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August 1991

AUSTRALIA'S LARGEST SELLING ELECTRONICS MAGAZINE — ESTABLISHED IN 1922

Louis Challis tests the Apogee 'Stage' system

Electrostatic and ribbon speakers are the only way to get truly 'transparent' sound, say their devotees — but they also tend to be BIG. Louis Challis has been testing the new Apogee Stage system, which is smaller than most; see page 10.

Professional electronics: new range of Tek DSO's

In this month's News Highlights section, in the professional supplement, we cover the release by Tektronix of two new digitizing scopes featuring 1GS/s sampling, 4ns glitch capture and an 'intuitive' graphical interface. (See page 118)

On the cover

We're rather proud of Rob Evans' new benchtop supply design, which provides all of the features and facilities that many people are likely to need, for the best possible price. Rob's article starts on page 72... (Picture by John Fryz)

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Projects and Technical

Professional Electronics

Columns and Comments

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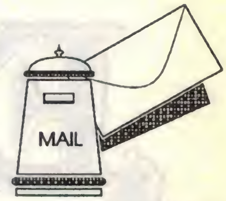
LETTERS TO THE EDITOR



Time switch project?

This letter is inspired by yet another disastrous morning, being woken up by the harsh 'beep' of my alarm clock (virtually useless because I fall asleep immediately after turning it off).

I once had a mains time switch arranged to switch on my tape deck, to produce a blast of my favourite music each morning.

Not being irritating, the music did not get switched off and hence, I remained awake. Unfortunately, my mother has 'reborrowed' the time switch (which was five minutes earlier each morning anyway!).

Perhaps *EA* would like to do a timeswitch project based on this idea, the tuner being regulated by mains frequency perhaps, and having a bypass switch so that the tape deck may be operated through the timeswitch's 'off' cycle.

To complement this, perhaps an automatic lamp dimmer circuit could be arranged to gradually switch on a bedside lamp over about 10 seconds, giving the sleeper's eyes time to adjust (I find nothing worse than switching on a lamp first thing on a dark morning).

I am not sure how many other people would be interested in such a project, but I certainly would.

Keep up the good work and keep those projects rolling in!

Julian Phillips,
Temuka, NZ.

Comment: Thanks for the suggestions, Julian. We'll see what can be done — although time switches are available commercially for such low prices nowadays, that it would be hard to compete.

Why be a ham - 2

Referring to Patrick Zachariah's letter in the May issue, Patrick has made the right decision.

The Amateur Radiocommunication Service (ARS) is not suitable for general chin-wagging: it is for girls and boys, men and women with inquiring minds, not to acquire wealth, but to improve their knowledge and to enrich their experience of radio technique.

The spectrum reserves (amateur bands) are for that purpose, to enable self training, technical investigation and incidental intercommunication by amateurs. People who join the service for the wrong reasons can be disappointed and leave or become ham communicators and be a nuisance to the bona fide members.

It is important for prospective amateurs to get the right information: recruitment campaigns which sell the ARS as a hobby are not the best source.

The ARS is more than a hobby, it is an established international communication service benefitting the community in many ways.

In the long term the community might not continue to forego potential profit from the amateur bands if the service is degraded to just a hobby.

EA published informative unbiased articles about the ARS in the mid-eighties. Perhaps the Editor would re-run those.

Lindsay Lawless,
Lakes Entrance, VIC.

Comment: Perhaps we might, Linday, if there's enough interest. But why are the terms used to describe amateur radio getting longer and more pretentious all the time, even though amateurs seem to be doing less and less of the original radio experimentation? The average age of amateurs is getting higher and higher — ever thought that with high-flown labels like the 'Amateur Radiocommunication Service', you might be putting young people off?

Optical switch

I am an electronics engineering student currently building a project which allows 35mm slides to be viewed in three dimensions.

The process involves projecting two slides (left view and right view) alternately onto a screen in rapid succession, and allowing one eye at a time to view the appropriate slide. Although I have a number of sources for electronic components, there is one item for my project that I haven't been able to find a source for. I need a special lens or laminate material, which can switch between being opacque and transparent according to the voltage applied to it, similar to a liquid crystal device.

It needs to be used as an electronic shutter which can alternately block light,

then let it pass through. I have seen some special liquid crystal 3D glasses (X-specs) available for the Amiga computer that do just what I want, but I cannot locate the manufacturerer (need just the lenses, not the expensive software that comes with them.)

If any readers are able to give me some relevant information or if they have had experience in a similar experiment that they might like to share, I would be grateful if they would reply either in this magazine, or to me personally at the following address:

Mario Annetta,
69 Boldrewood Parade,
Reservoir, VIC 3073.

TI computer user group

On what is known as Black Friday in 1983, Texas Instruments announced that they would cease production of their popular TI99/4A home computer.

The reasons for this are a little beyond the scope of this letter, however there followed a period where quite a number of these computers were sold in Australia, and throughout the world.

Contrary to what would be expected, there is still a strong following for these computers in Australia. But there are also a very large number of owners who are 'lost in the wilderness' because they are not aware of th e existence of the User Groups that exist throughout the country. These people often contact computer suppliers or servicemen for help but are all too often told that they haven't heard of them for years and that there is nothing that they can do to help.

I am sure that a significant percentage of computer suppliers and particularly servicemen regularly read this fine magazine and I would like to take this opportunity to point out assistance is available from TI99/4A owners in most states of Australia.

The user groups can provide software, repairs and hardware enhancements for the TI99/4A. I should point out that while this is an outdated computer there is still new software being produced.

Most applications written for PC's and other popular computers are available in one form or another for the TI. In the hardware line, it is possible now to modify and add to the TI99/4A so that it would be hardly recognisable to the original designers.

Anyone with enquiries can contact their local user group or write to me at PO Box 3051, Clontarf MDC, QLD 4019.

Garry J. Christensen,
Secretary,
TI-Brisbane User Group.

EDITORIAL VIEWPOINT

A good idea that should be taken further

I've just had a chance to look through the 'Advisory Code of Practice' for the domestic electronics service industry, which was recently published by the NSW Department of Business and Consumer Affairs. It seems a very worthwhile move, aimed both at lifting the standard of service delivered by people and firms involved in repairing domestic electronics equipment, and also at raising the awareness of consumers with regard to the level of service that they're entitled to expect.

I hope similar codes are adopted in other states, so that the quality of electronics servicing is raised throughout Australia — not just in NSW. And hopefully this will happen, because many national bodies and organisations were involved in, or at least consulted when the NSW code was being prepared: The Consumer Electronic Suppliers Association (CESA), the Television and Electronic Services Association (TESA), the Electronic Services Industry Association (ESIA) and The Electronic Technicians Institute of Australia (TETIA).

But while this kind of code is commendable, to my mind it doesn't go nearly far enough. For example there's the problem of availability and pricing of replacement parts, which was even noted by NSW Business and Consumer Affairs Minister Gerry Peacocke when he was actually launching the NSW Advisory Code.

Frankly the cost of replacement parts often seems to be exorbitant — assuming, that is, that they're even still available, by about four or five years after purchase of the appliance. Many manufacturers seem to give minimal support of their products past their official warranty period, giving every impression that they want the consumer to throw away the appliance at that time and buy a new one. Try getting a replacement part like an RF booster/modulator module for your seven-year-old VCR, for example, as I did recently. When I finally did find out where one could be obtained, I was absolutely staggered by the price of around $130 — about *four times* what I would have expected!

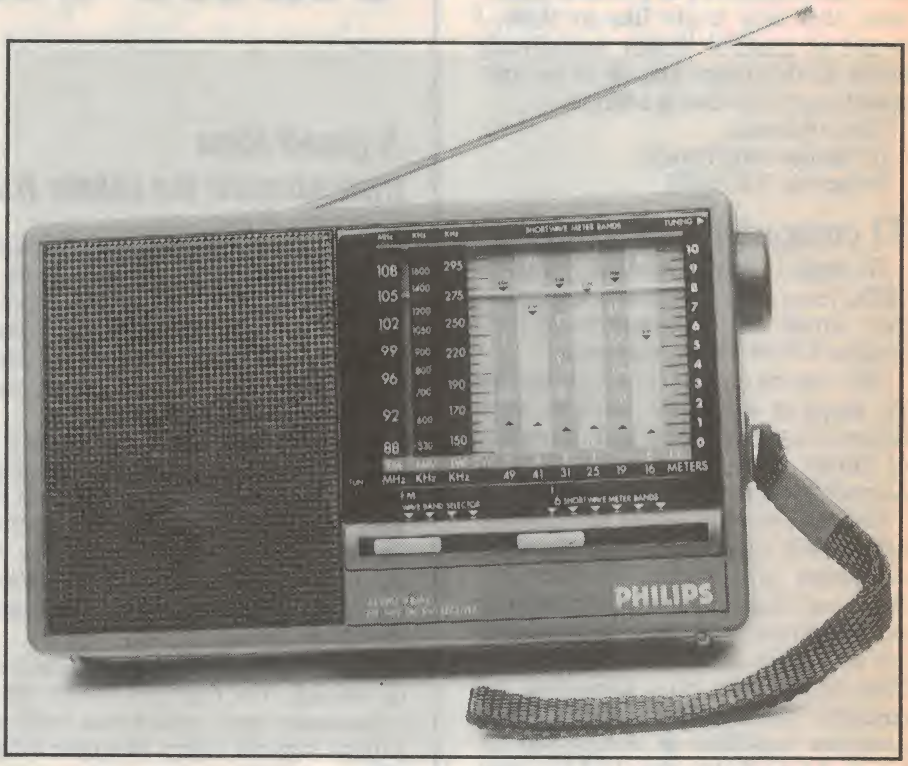
Another area that simply hasn't been addressed by the current Advisory Code is the need for adequate servicing information to be made available by the appliance manufacturer. Many manufacturers are very poor in this area of support, producing manuals that are either inadequate, overpriced or in such short supply that they're very difficult for either service technicians or customers to obtain. This makes it almost impossible for the technician to provide the correct standard of servicing.

My *own* view has always been that manufacturers should be legally forced to provide adequate service manuals for all electronic equipment they sell, along with the equipment itself and included in the price. That way, we'd all be able to ensure that at least the information needed to service our equipment was always available. But at the very least, surely we should insist that adequate service manuals are available to any service organisation or technician, at a nominal charge only and for a period extending at least 10 years beyond its withdrawal from sale.

Jim Rowe

What's New in VIDEO and AUDIO

New multi-band radios from Philips



Philips has released a very compact nine-band radio receiver — receiving FM, LW and MW signals as well as six shortwave bands. The AE3205 receiver has both telescopic and ferrite rod aerials for the reception of signals from around the world. Convenient features including a LED tuning indicator, an earphone connection, the ability to run off mains or battery power and a hand strap for easy listening.

For those who want higher performance the dual wave version AE3405 spreads the shortwave broadcast spectrum over nine shortwave bands as well as picking up FM, LW and MW broadcasts. AM/FM switching is electronically controlled and indicated by a LED, while a lock button guards against accidental switching between AM and FM. A separate AM band selector is incorporated into the AE3405. Control in tuning is facilitated by an easy to use thumbwheel.

Stereo sound can be achieved by plugging a stereo headphone set into the socket provided and the Philips Dynamic Bass Boost adds depth to bass reproduction. Philips also includes a guide on shortwave frequencies, and an attractive carry pouch.

The Philips AE3205 is available now at around $99.95, while the AE3405 sells for around $129.95.

New MATV, CATV amplifiers from Hills

Hills Industries has launched a new range of master antenna (MATV) and community antenna (CATV) television signal amplifiers for professional installation. The new range includes equipment suitable for hotels, schools, hospitals and motels, as well as retirement villages, mining towns and caravan parks. The system consists of Prolink distribution and repeater amplifiers; Modulink Plus, a complete assembly suitable for any size system; equaliser filters and combiners; and splitters and directional couplers.

Prolink is designed to drive medium to large MATV systems and consists of the Prolink 1A wide-band distribution amplifier; the 1B amplifier with separate switchable VHF and UHF inputs; the 2A repeater amplifier, a basic line repeater; and the 2B repeater which can be used as a normal down-line repeater but also incorporates reverse path amplification.

Modulink Plus is a head-end assembly in modular form mounted on a pair of rails and includes a power supply, single channel amplifiers, audio/video modulator, and frequency converters. Modules plug into neighbouring modules via a sub-miniature D15 connector, modified for RF, that carries the signals between units along with the power supply. Hills has also produced a new range of equaliser filter and combiner units for use with Prolink and Modulink that also allow manual adjustment of signal levels in various frequency bands. The splitters and directional couplers, which are designed to operate down to 5MHz, meet the demanding technical specifications of the State Housing Commission of Victoria.

Hills Antenna and TV Systems Division has offices in Victoria, New South Wales, Queensland, West Australia, South Australia and New Zealand to assist with technical information and advice.

First 'live to CD' recording in USA

The Music Engineering Program at the University of Miami has made what is probably the first direct to compact disc recording in the United States. The event was a concert featuring legendary jazz guitarist and former U of M student Pat Metheny, backed by theUniversity of Miami's Concert Jazz Band under the direction of Whit Sidener. The recording was made live to a Denon DN-7700R CD recorder. Laura Tyson, Broadcast Products Manager of Denon America, provided the recorder and was on hand to encode the disc. Recording duties were handled by John Monforte, Assistant Professor in Music Engineering and John Beers, a senior in the program.

The concert featured big band arrangements of several Pat Metheny compositions. The new arrangements were written for the concert by faculty and students in the jazz program at the University and were performed to a sell-out crowd.

The completed pair of discs were assigned track numbers and presented to Pat Metheny before he had finished packing up his guitars.

Professional digital audio recorder

Otari has developed its new DDR-10 Professional Digital Audio Disk Recorder/Editor to address many of the needs of the professional studio and broadcast markets.

The DDR-10 is said to provide a fully integrated and configured 'plug-in-and-use' ergonomic work console, incorporating a familiar tape machine remote-like control surface and all support hardware and software.

Software for the unit comes from Digidesign, a recognised leader in DSP software and hardware for the Apple Macintosh.

The standard DDR-10 system includes a 19" high resolution monochrome monitor, analog and digital inputs and outputs with Apogee filters, +4dBm active balanced inputs and outputs, AES/EBU and S/PDIF digital I/O's, MIDI in/through/out ports, a 345MB hard disk and 5MB of RAM — all mounted in an integral console.

The hard disk provides a minimum of 30 minutes of stereo digital audio at 44.1kHz sampling rate. Otari claims its dedicated hardware control panel and jog/shuttle wheel makes the DDR-10 fast to operate, and allows all operations to be performed directly from its sufrace without a mouse or keyboard.

Otari products are represented throughout Australia by Amber Technology, Unit B/5 Skyline Place, Frenchs Forest 2086; phone (02) 975 1211.

Digital audio message store

Creative Audio has released the DMS1 Digital Message Storage System, a cost effective message annountment system using computer memory as the storage medium. The DMS1 is designed for commercial, industrial and display applications to provide alert, warning and evacuation messages, public announcements, product information or sound effects.

The DMS1 employs digital encoding technology to provide solid state audio messge storage and retrieval. Unlike other systems which use EPROM devices as the storage medium, the Creative Audio DMS1 employs battery backed dynamic random access memory (DRAM), which provides the ability to record and change the message immediately — no additional hardware is required. The DMS1 uses no moving parts or other components which deteriorate over time, ensuring a long mean time before failure period and no degradation of audio with continuous use.

The DMS1 will hold one message, in mono, up to 30 seconds in length. Front panel controls are provided for play and record functions, with a 10 segment LED bargraph display for time remaining. Remote control of start, stop, pause and record functions are accessed through a rear panel connector. Balanced line level input and output connectors are also located on the rear panel.

Power for the DMS1 is provided by an external DC plug pack, supply with the unit. In the event of a power failure, an internal battery will retain the stored message for over 16 hours.

The DMS1 measures 120 x 95 x 55mm and is exclusively designed and manufactured in Australia by Creative Audio of 11/1 Wentworth Road North, Homebush 2140; phone (02) 746 1199.

Digital sound field processor for cars

The interior of modern cars is a relatively unfriendly acoustic environment, making it difficult to achieve high quality sound reproduction with conventional equipment. But Yamaha's engineers have developed a new digital sound field processor, the YDSP-C1, designed especially for this purpose.

The YDSP-C1 connects between conventional signal sources such as a CD player, cassette tape player or tuner, and a standard four-channel power amplifier and speaker system. It provides custom DSP control over the five primary acoustic parameters (initial delay, room size, 'liveness', reverb time and high cut), allowing the characteristics of the complete in-car system and environment to be optimised.

There are also eight pre-programmed sound field combinations, synthesising the acoustics of a concert hall, music chamber, church, stadium, jazz club, disco, rock concert or theatre. It also provides a filtered output for a subwoofer amplifier system.

The YSDP-C1 employs five Yamaha-developed LSI chips designed expressly for audio DSP applications.

It uses 16-bit A/D conversion with 32-times oversampling, and 18-bit D/A conversion with four-times oversampling. Input and output signal levels are 1.5V RMS, with a rated frequency response of 20Hz - 20kHz, THD of 0.03% and dynamic range of 90dB. The unit consists of a dash-mounting control unit, connected to a 'hide away' processor unit. It is expected to reach Australia in October.

'Digital noise absorber'

TDK has introduced the NF-C09 Noise Absorber, which uses a TDK proprietary ferrite core to suppress digital hash in audio systems. The TDK Absorber is designed to be placed as close as possible to the source equipment, namely on the output cables of the CD player.

The Absorber is suitable for cables of diameters up to 9mm. TDK claims that the Absorber is also effective on digital musical instruments and DAT recorders. The NF-C09 Noise Absorber has an RRP of $24.95 and is available at selected department stores and TDK dealers ■

Hifi Speaker Review:

AUDIOSOUND'S 8033A 'MINUET' SYSTEM MKIII

Award-winning Australian hifi manufacturer Audiosound Laboratories has upgraded and enhanced its midrange 8033 'Minuet' model a number of times, since it was first released in 1972. As a result the latest MkIII version offers really excellent performance, at a very competitive price.

by JIM ROWE

Ask the average Australian hifi enthusiast to name three manufacturers of high quality loudspeaker systems, and the odds are that they won't come up with one Australian firm. You'll get much the same result if you ask them to name three makers of hifi amplifiers, of course. Yet Australia has an active hifi manufacturing industry, whose products are basically equal in quality to those produced anywhere else in the world. In fact many of them are very highly regarded *elsewhere* in the world, as they undoubtedly deserve to be. But here in Australia, most of them are virtually unknown except to a few afficionados.

It's a sobering fact, but true: within Australia itself, our local hifi manufacturers are almost invisible. Perhaps it's because they haven't got the bickies to spend on fancy advertising and promotion, or are just better at designing and making good products than they are at marketing. Or perhaps it's simply another example of the traditional Aussie unwillingness to believe that a home-grown product could be as good as one that's imported from overseas.

The products of Sydney firm Audiosound Labs are a good case in point. Company founder and principal Ron Cooper has been making high quality speaker systems since 1968, many of which have found their way into professional 'monitoring' situations, including the ABC.

Ron was one of the first speaker system designers to recognise the significance of the work of Neville Thiele and Dick Small, and to incorporate their seminal insights and design methodology into his designs, well ahead of most overseas designers. Most of his designs have even had the added benefit of direct informal design involvement by Neville Thiele himself, our world-acknowledged Aussie guru on the subject — an undoubted advantage that virtually no other loudspeaker system maker can boast.

Audiosound's speaker systems also won a prestigious Australian Design Award last year, as we reported in our December 1990 issue, and were commended for their quality construction, finish and audio performance. Yet they're still in many ways 'well kept secrets', known to only a minority of potential buyers...

You get the idea, I'm sure. The point I'm making is that Aussie hifi manufacturers make excellent world-class products, which deserve much more recognition and patronage than they get. My hat's off to the 'Ozfi' industry promotion group, for its efforts towards achieving this recognition. Hopefully *EA* is also playing its part, with our frequent articles and reviews bringing Australian products to our readers' notice.

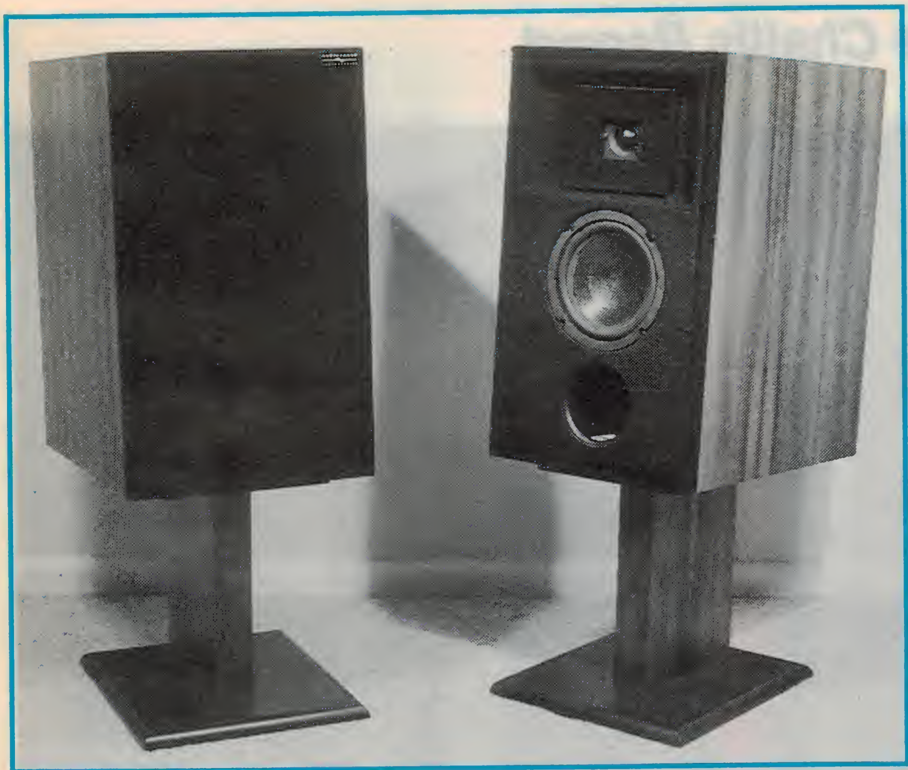
But enough of the flag-waving preamble. Let's now turn to the subject at hand: the latest 'Mark III' version of Audiosound's well proven mid-range 8033 *Minuet* system, which first appeared in its original form in 1972. Over the intervening 19 years it has been upgraded, enhanced and fine-tuned a number of times, but is still based on the original design concept.

Ron Cooper jokingly describes the 8033 as 'softspeaker' rather than a 'loudspeaker'. But this doesn't mean that it lacks either power handling capability or incisiveness, he hastens to add. What it's meant to convey is that the 8033 is designed to place primary emphasis on smooth, clean and very wide-range reproduction, rather than on being able to cope with the highest possible power levels. The 8033 is based on medium sized two-way bass reflex enclosures, using a 170mm long-throw bass driver teamed with a 25mm dome tweeter. The woofers are imported units with an aluminium voice-coil former and heavily doped cone, which are 'customised' by Audiosound in house to achieve the desired performance. The tweeters are the well-proven HF8 units, which offer wide dispersion and emerged as 'best performer' from Dick Small's original impulse testing work at Sydney University.

The 8033 enclosures are relatively deep, measuring 495mm high by 295mm wide by no less than 430mm deep. They're also very solid, finished with genuine American Walnut wood veneer and with heavy internal bracing using pillars directly behind the woofer mounting points.

The woofers and enclosures in the 8033 are carefully matched according to Thiele/Small alignment, to achieve a bass response extending down to an impressive 35Hz at the -3dB point, and just on 30Hz at the -6dB point quoted by some overseas makers. This is with a very tiny 0.1dB peak at about 48Hz, and represents a much more extended bass response than that achieved by many systems of either comparable or larger size, and costing considerably more. It also obviates the need for a supplementary sub woofer, often needed to achieve satisfying bass performance with compact systems.

For the latest 8033A MkIII version, the bass drivers have been given increased suspension travel to allow for larger cone excursions. At the same time the suspension has been arranged to 'self limit', preventing audible bottoming of



the coil former against the magnet assembly during excessive bass drive. The port diameter has also been increased, with suitable adjustments to preserve the alignment, to lower venting velocity and improve 'breathing'.

The HF8 tweeter is time aligned, and mounted in a felted and chamfered recess to minimise diffraction effects and improve phase and transient definition. It is also fuse protected, and fitted with a three-position HF level control to allow adjustment of top-end balance according to the listening room acoustics and individual taste.

As with previous versions of the model, the 8033A MkIII uses a third-order crossover network, with a slope of 18dB/octave and phase/impedance equalising. This is very carefully adjusted to minimise tweeter diaphragm movement (and hence distortion) in the crossover area, while also minimising relative phase shifts and time delay. Each crossover uses 12 elements, and uses only air-cored inductors and polyester capacitors for minimum distortion. Quoted nominal load impedance of the 8033A MkIII system is eight ohms, with a rated frequency response of 35Hz - 20kHz. It is designed to be used with amplifiers rated anywhere from 20W to 100W per channel.

What we found

Ron Cooper very kindly loaned us an 8033A MkIII system, complete with optional (but recommended) floor stands, for a couple of months so we could try it out for ourselves in a typical domestic listening environment — my own home loungeroom, in fact. This allowed me to evaluate the system using both basic instruments (audio generator, sound pressure meter etc) and a wide range of musical programme material.

The amplifier used to drive the system was the new Pioneer A-400, as reviewed in the July issue. This has an output of around 60W per channel, with excellent distortion and noise performance as well as a very flat response, and turned out to be well matched to the Audiosound system.

First of all, I tried running the generator over the bass end of the spectrum, to verify the 8033A's impressive low end response. As far as I could determine, it was exactly as claimed, with solid output down to just below 35Hz. There were no funny bumps or lumps, either — just smooth and clean reproduction.

Then I ran the generator further up into the mid-range crossover region, where many systems *do* start to exhibit bumps, lumps, odd little resonances and phasing artifacts. Again there was really nothing to discover; merely a smooth and fairly rapid transition from the bass driver to the tweeter.

As a last check with the generator I swept over the top end, and also did a few quick checks of beam width with the SPL meter. But again things were very uneventful: there were no obvious peaks or dips, and the radiation pattern at the high end seemed smooth and broad. So I put away the instruments, and settled down for some sessions of relaxed but careful listening.

Over the next few weeks I was able to have quite a few sessions listening to the system, with a variety of different kinds of programme material from both CDs and the FM tuner. And to be honest, the longer I listened to the system the more it confirmed my initial impressions: that the 8033A is an exceptionally smooth, clean and well balanced wide-range system. Very early in the sessions I discovered that for my particular listening room, the speakers sounded a little too bright unless I turned their HF level switches down to the '2' position. But after that, it didn't seem to matter whether I played solo vocalists, choral music, orchestral music, solo instruments like flute, guitar or piano, concertos or a full concert pipe organ — the reproduction was clean, balanced and without any obvious colouration. And with its extended bass response, coupled with a lack of distortion, the 8033A system also provides a remarkably warm and unforced 'big speaker' sound, as well.

As for it perhaps tending to be a 'softspeaker' rather than a 'loudspeaker', that certainly doesn't seem to be a problem in a typical domestic situation. It would produce more than enough volume for normal or even 'loud' listening, in my experience. In fact even turned up briefly to levels where my neighbours were probably contemplating a complaint to the local police station, there was no real sign of distortion or other embarrassment.

In short, then, I found the Audiosound 8033A MkIII speaker system an excellent performer. It's very easy to listen to, and with its smooth and extended bass response seems well suited for either domestic or professional monitoring use.

At the quoted price of $1649 for the basic system plus a further $195 for the optional floor stands, it also seems to represent good value for money. If you're looking for really wide range reproduction coupled with compact size and smooth unforced sound, it would have to be on your shortlist.

Unfortunately as with other Audiosound systems you won't be able to find it in many hifi dealers. It's only available from 'selected dealers', or direct from Audiosound itself. For further information, including details of your nearest dealer, contact Audiosound Laboratories at 148 Pitt Road, North Curl Curl 2099 or phone (02) 938 2068. ■

APOGEE 'STAGE' RIBBON SPEAKERS

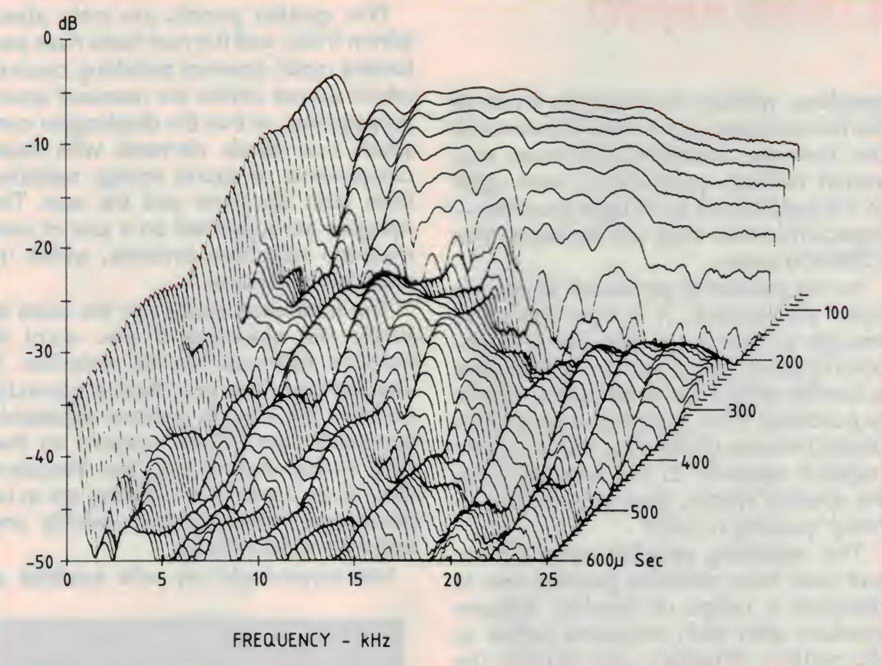
'Panel' loudspeakers such as the electrostatic or ribbon types have a reputation for providing the most 'transparent' delivery of program material. They also tend to be relatively large in diaphragm area, particularly where acceptable bass response is sought. This month Louis Challis has been testing the new Apogee 'Stage' ribbon system, which is claimed to combine full range reproduction with reasonably compact size...

It seems that I am only one of the many Australians who have been infatuated by electrostatic and/or ribbon loudspeakers. Now don't get me wrong, it's not that I am so easily seduced; but rather that even early electrostatic speakers offered a level of performance and a range of related characteristics which their very distant cousins, the dynamic loudspeaker clan, just couldn't quite seem to match.

It is now more than 20 years since I bought a pristine pair of Quad electrostatic speakers, and although my infatuation blossomed into what could easily be described as a 'wild romance', it should be noted that neither my wife nor my family were imbued with quite the same feelings.

Of course my 'infatuation' wasn't quite as blind as you might suspect, because I understood and tacitly accepted the all-too-obvious limitations of my Quads. As well as an ungainly appearance, I was forced to accept their inadequacies in terms of reproduction at frequencies below 100Hz. Those inadequacies were temporarily resolved by adding a subwoofer to the system. One of the most disturbing limitations in almost every electrostatic speaker system, and in many of the later ribbon speakers that I have reviewed, has been their inability to faithfully reproduce low frequencies. And the lower the frequency, then the more difficult that task becomes. The amplitude of motion required to adequately reproduce those low frequencies imposes extremely complex demands on the diaphragm of this kind of speaker. These demands can only be really satisfied by using larger diaphragms, and ultimately of course by much larger and visually intrusive speaker panels.

Neither the first nor second generation of Quad electrostatic speakers ever really solved the problems and inadequacies at low frequencies. In any case they had numerous other peccadillos — not the least of which were the selenium rectifiers which the first generation had adopted for their high voltage power supplies. Those particular archaic devices had a nasty habit of failing prematurely, particularly if you did not regularly switch off the mains power after listening to them, and of making their demise known in a delightfully malodorous way.



The decay response spectra analysis for the Apogee 'Stage' ribbon loudspeaker, showing the smooth and fast decay characteristic at middle and high frequencies but also the resonant characteristic at low frequencies.

Latest technology

The latest ribbon speaker technology has sidestepped the need for nasty high voltage selenium power supplies (even though suitably protected silicon rectifiers would have solved the reliability problem, at least). Right on cue, technology has developed modern ferrite strip magnets and even more esoteric complex products like samarium-cobalt strips of magnetic materials, which make it possible to achieve unrivalled characteristics with modern ribbon speakers. These now use specially formulated ultra-thin diaphragms, suspended between stacked arrays of matching magnets.

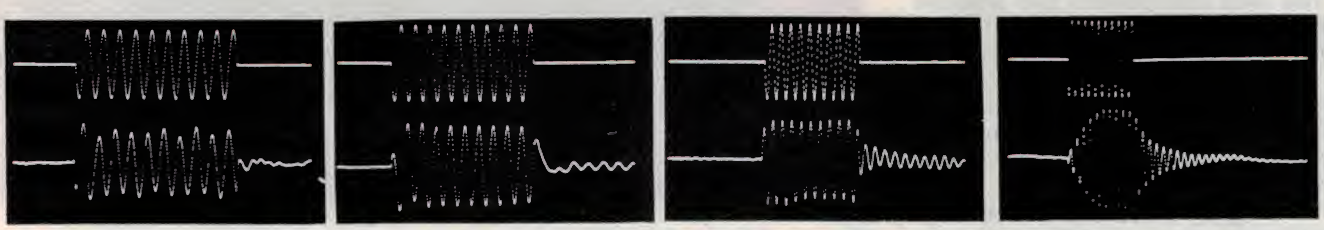
One firm which has 'leap frogged' past the Quad company's original developmental work, and which has developed an enviable reputation in its own right is Apogee Acoustics Incorporated, located in the state of Massachusetts on the eastern seaboard of the USA.

The firm's designs have adopted well-proven ribbon tweeter technology, from which they have progressed with a system which is far simpler, in that it no longer requires high voltage supplies nor complex transformers.

The first of their speakers, the original Apogees (which I note they still market, but now under a different name), are a monumental 2m high, and half as wide again. Ribbon speakers with such large dimensions can achieve reasonable, if not good, low frequency performance, even if they do tend to dominate the appearance of the room in which they are placed.

Now there are of course relatively few residential situations in which a male of the species could readily place such large

100Hz (20ms/div). *1kHz (2ms/div).* *6.3Hz (0.5ms/div).* *47Hz (100ms/div).*



Four tone burst response plots for the 'Stage' loudspeaker, showing its transient response. The upper trace in each case shows the electrical input, with the loudspeaker's output below. All plots are with 90dB steady state SPL at 2m on axis.

Challis Report

speakers, without incurring the wrath of his female mate. For it is my observation that there are relatively few women who would willingly purchase or even agree to the purchase of such large speakers — especially when they sell for more than US$8000 a pair.

As the marketing personnel at Apogee soon discovered, it is just not good enough to have a speaker that is exceptionally good; you must also have to have a speaker which the marketplace wishes to purchase. If the prospective purchasers object because of the size, and state their negative response to the appearance of the speaker system, then you are proverbially 'pushing it uphill'.

The marketing people's approach, as you have most probably guessed, was to develop a range of smaller Apogee speakers with such evocative names as 'Scintilla', 'Duetta', and finally the 'Caliper'. Each of these successive systems was either cheaper or smaller than the original Apogee, and consequently they sold in significantly larger numbers.

Of course price is important, but then so too is performance. And after resisting untold 'sling shots and arrows', the Apogee firm's most recent response was to develop the Apogee 'Stage' system, which is a smaller system, with what they claim to be a 'better wide range performance'.

The Stage speakers are almost exactly the same height as my existing monitor speakers at home, and to use my wife's bland description, "they are no more ugly"! (It's nice to know that one's toys are appreciated.)

The Stage ribbon speakers are however significantly wider, and they make additional demands in terms of clear space both in front and to the rear.

Because of their relatively thin and flat profiles, they still make a very strong visual impact. Each of the speakers has an expanse of flat black solid facia, with a trapezoid-shaped frontal face, which is neatly trimmed on both sides with mahogany. (They are available with other colours and finishes, but that is very much a matter of personal taste.)

The face incorporates two separate areas of recessed expanded mesh — one relatively large and the other tall and thin — behind which the ribbon elements are suspended. With the light at the right angle, you can readily view the neat profiled faces of each of the distinct areas of diaphragm.

The long thin vertical ribbon section of the tweeter's diaphragm is located on the side closest to the middle of the room, and does not detract from the appearance of the system.

The speaker panels are only about 50mm thick, and the rear faces have perforated metal covered matching cut-outs which do not inhibit the rearward sound propagation, so that the diaphragms constitute true dipole elements with equal components of sound energy radiation from both the front and the rear. The Apogees are supported on a pair of rear-mounted adjustable brackets, which incline the front panel.

The handbook spells out the need to angle the speakers if you want to achieve optimum sound emission. It also advises that you should correctly position the sharply pointed adjustable (screwed) rear spiked supports so that they firmly extend into the (wooden) floor of the room in which they are to be placed, to ensure positive stability and optimum sound quality.

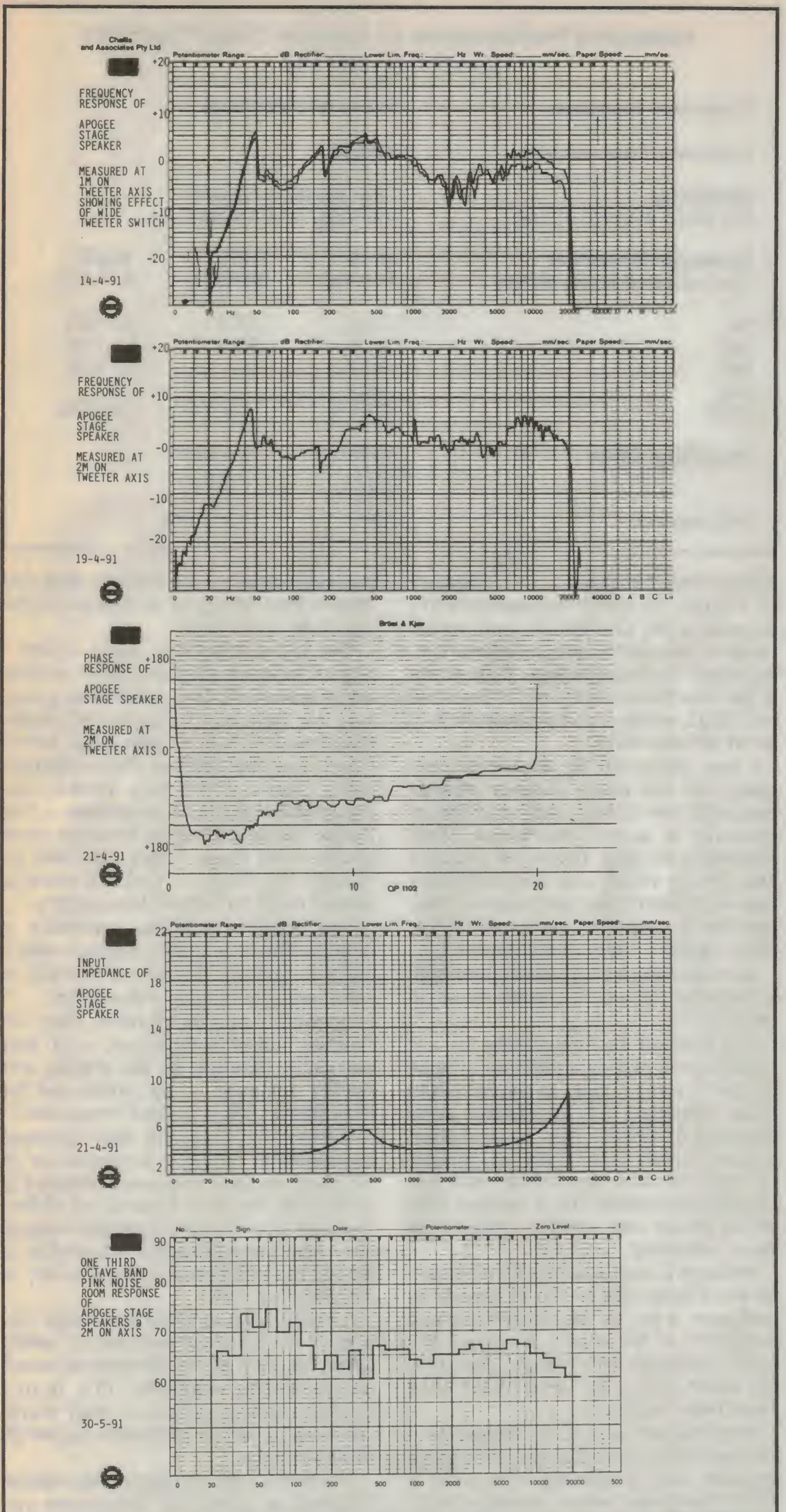
Not surprisingly my wife baulked at that, and I don't doubt that quite a few other prospective owners will experience comparable embarrassment.

That problem can of course be partially resolved by reversing the screwed spikes and placing appropriate weights on the rear feet to achieve an appropriate level stability.

The rear of the speakers also incorporate a double set of terminals which are designed to be used in a 'bi-amplifier' configuration, to optimise the sound quality and minimise the adverse interaction that a single pair of leads and a single amplifier channel apparently produces.

Although they are relatively thin, the Stage speakers are unusually heavy, and at 25kg each (without packing), prove to be rather unwieldy — especially if you are forced to handle them without assistance. The dimensions are 980 x 670 x

The rear of one of the 'Stage' loudspeakers, showing the support brackets, the input terminals and tweeter level switch, and the rear openings for each driver element. The wide darker band down the centre of the mid-range driver is the array of magnets, cemented to the perforated steel back panel.



Various response plots for the Apogee 'Stage' loudspeakers. Note the smooth phase response, the low minimum input impedance and the bass peak evident in both the main response plots and the one third octave pink noise response.

240mm (H x W x D, including the support brackets).

Reverse procedure

For a variety of practical reasons, I elected to reverse my normal procedure, and took the Stage speakers home for an initial subjective assessment, before taking them back to the laboratory for what was clearly going to be an interesting exercise.

My first impressions of the Stage speakers during a short recital at home were reasonably favourable, particularly in terms of their performance on classical music and on speech. So I packed up one of the two speakers again and took it back to the laboratory, to put it through its paces.

The first series of tests, which I conducted in the anechoic room, was to determine the on-axis frequency response characteristics. Those measurements revealed that although the Stage has a frequency response which is relatively smooth above 150Hz, the low frequency response was anything but smooth. The peak in the response between 30 and 70Hz was not really what I would have expected, and I really wondered why I had not noticed how peaky and limited the low frequency characteristics were during my first subjective foray at home.

By contrast the smooth response above 200Hz was fully in keeping with my subjective impressions, and was a confirmation of the design characteristics and primary attributes of the system.

I noted that when the single rear panel control was switched from the 'normal' to the 'high' tweeter switch position, this only provided a modest change — in the order of 3dB — at frequencies above 5kHz. This was quite uniform across the top of the tweeter range.

The measured phase response was remarkably smooth, and unlike the Quads and most of the other ribbon or electrostatic speakers which I have previously evaluated, exhibited none of the irregular or cyclical perturbations in the phase response which were a feature of those other speakers. Of course a smooth phase response augurs well for the transient sound quality, particularly if it is matched by a reasonably smooth frequency response.

The measured impedance curve for the system, with both sets of terminals interconnected in parallel, provides an unusually low impedance — a whisker above three ohms, which is potentially low enough to be embarrassing with some amplifiers. Obviously this low impedance characteristic is the underlying factor behind the designers recommending a 'bi-amplifier' drive configuration.

The decay response spectra caused me

disturbing problems, because of a thermal bug in the IEEE interface of my Fast Fourier analyser. This had the disturbing result that it would lock up the interface from the computer, and preclude any chance of plotting out the full decay response spectra.

Whilst I have not yet resolved that problem, I was able to extract sufficient information to plot out enough of the decay response spectra to publish a set of curves.

The decay response spectra analysis that I did finally record confirmed very positively that the mid-range and tweeter sections of the Apogee Stage are unusually smooth, with an equally fast and smooth primary decay characteristic. There were of course some signs of low level reflections, particularly in the region between 5kHz and 10kHz.

Not unexpectedly, the low frequency driver's resonant characteristics show up 'loud and clear', but for all that, the decay response characteristics are particularly good and highlight the underlying reason why this particular speaker system has such a smooth presence.

It also explains why they have an almost 'transparent' characteristic in terms of their reproduction sound qualities. The conventional tone-burst testing confirmed that whilst these speakers do exhibit some modest traces of ringing at high frequencies, the only point in the frequency range where there is a real resonant characteristic (and slow decay), is at the 47Hz peak of the low frequency section.

I briefly examined the directivity characteristics of the speakers at high frequencies, and was gratified to find that the tweeter's response was reasonably uniform within a +/-30° arc, although outside that angle the high frequency response drops away quite rapidly.

I also examined the one-third-octave band pink noise room response, and discovered why the Owner's Manual recommends that these speakers be positioned out by 36-48" maximum — i.e., approximately 1-1.2m from the rear reflecting wall.

With this spacing, the reflected low frequency peak at 47Hz is diminished, and the overall frequency balance is enhanced.

Subjective appraisal

My subjective appraisal of the Apogees was made all the more pleasurable by some exciting new discs.

I started with an album from the Complete Mozart Edition, which Philips have been progressively issuing since October last year and which because of its size will continue throughout 1991. I have all of Volume 3, which incorporates his Serenades for Orchestras, and which contains some of Mozart's most entertaining music. Foremost amongst these works is the 'Eine Kleine Nachtmusik' Serenade in G K525, which is undoubtedly the best loved of these works.

I was entranced by the music, but noted that this music contains minimal content below 100Hz. With that limited spectrum of music, the Apogee Stage speakers provide a frequency response and fidelity which was unquestionably superior to my Quads, and moreover they provided a degree of realism which few other speakers could readily surpass.

My next test selection was derived from a delightful and what I consider to be an unusual disc.

This featured the duo pianists Tal and Groethuysen, playing a selection of some of Carl Czerny's most delightful piano music composed for 'four hands' (Sony Classical SK45936). Any serious piano student knows (fears?) the name Carl Czerny, and many I don't doubt, with less than fond memories. This is because most of his music was written primarily for piano practising.

Although Czerny was a brilliant pianist, he was almost unknown in his own time, and were it not for the acceptance and adoption of his music by countless music teachers both during and after his death, his name would have long since been forgotten...

What this disc clearly highlighted were the low frequency limitations of the Stage speakers, and specifically in terms of a mild dissonance when compared with my reference speakers.

Whilst not grossly disturbing, the low frequency characteristics achieved fall well short of Apogee's claims that these particular speakers are the only ones that 'deliver bass energy as transparent as the rest of the audio band'.

The last of the new discs which I played was an exciting new release which features Midori, the brilliant young Japanese violinist, playing Bartok's Violin Concertos Nos 1 and 2 with Zubin Mehta conducting the Berliner Philharmoniker (Sony Classical SK45941). Whilst I acknowledge that I have never been a true Bartok devotee, there are however some pieces of his music which I do like, although his second Violin Concerto doesn't really fall within that category.

The Stage speakers provided a reproduction mechanism through which an exceptional degree of fidelity is achieved, with minimal colouration.

I played a number of other discs, including vocal recordings, and was pleasantly surprised by the realism and fidelity achieved — for voice and for most (but not all) orchestral instruments.

Summarising, Apogee's Stage speakers constitute a complex compromise in which the designers have endeavoured to synthesize the best features of ribbon speakers in a visually acceptable module size, which should prove acceptable to the woman of the house, and possibly to the budget as well.

As with any compromise, some features of the Stage are exceptional, whilst others fall short of my standards of excellence. Notwithstanding, this is one speaker system which is well worth auditioning, as its attributes outweigh its deficiencies.

The RRP for the complete Stage system is quoted as $5995.00. The review system came from Australian distributors The Audio Connection, Shop 44, Suite 1, Old Town Centre Plaza, Bankstown 2200; phone (02) 708 4388. ■

Measured Performance of Apogee 'Stage' Speaker Serial No. 002147

Frequency Response	See level recordings		
Crossover Frequencies	350Hz		
Sensitivity (for 96dB average at 1m)	13.0 VRMS = 42 watts (nominal into 4 ohms)		
Harmonic Distortion (for indicated levels @ 1m)	**85dB 100Hz**	**90dB 1kHz**	**90dB 6.3kHz**
2n	-14.1	-57.1	-52.6dB
3rd	-31.0	-56.2	-61.7dB
4th	-31.7	-	-67.0dB
5th	-44.1	-	-
THD	20.1%	1.85%	0.25%
Input Impedance	100Hz	3.4 ohms	
	1kHz	3.8 ohms	
	6.3kHz	4.2 ohms	
Minimum at	50Hz	3.2 ohms	

Panasonic's MII & Digital 1/2" broadcast formats

Despite the apparent committment by Australia's TV stations and professional programme producers to the Betacam video recording format, Matsushita is putting renewed effort into giving them a 'second chance' with its MII format — which has proved popular overseas. The company has also developed a digital format, based like MII on the use of 1/2" tape cassettes.

by BARRIE SMITH

It would be easy for a space traveller, landing in any Australian capital city, to be misled into thinking the whole world ate MacDonald burgers, drove Toyotas, watched 'E Street' — and listened to Kylie.

Similarly, should our space traveller be literate in 'matters video', and fell through the ceiling of any News Department in any TV station in this country, he or she could be forgiven for accepting the delusion that the generic name for a video camera was 'Betacam'.

Currently Betacam and Betacam SP have an installed base in Australia of around 3,000 units. And such is the dominance of Sony's Betacam1 ENG2 and EFP3 camera/recorder systems that not only TV stations but documentary makers, corporate video producers, programme producers and many TV commercial makers survive and profit only by the grace of the 'go anywhere', highly portable and simple-to-operate equipment. In Australia, that is.

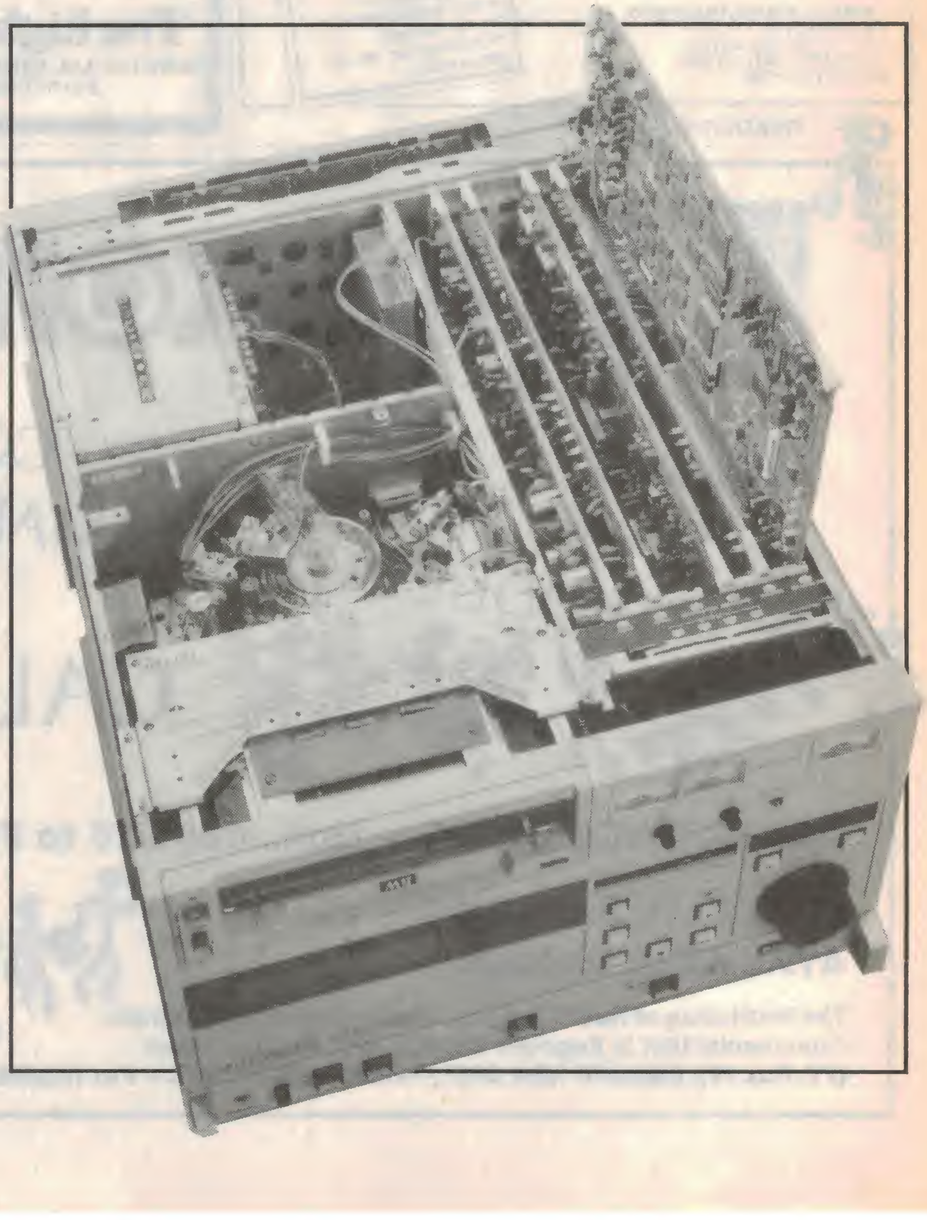
Intense war

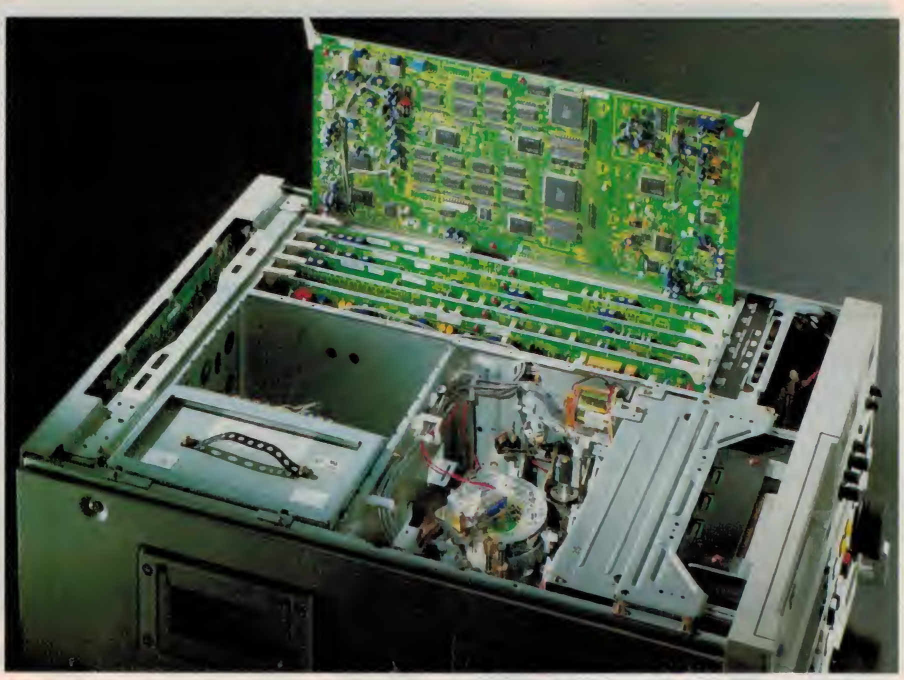
In a report of mine (*ETI*: 10/88) on the 1988 Sydney SMPTE Conference, I noted that a quiet, but nonetheless intense war was raging between the forces of Matsushita's MII and Betacam SP formats.

The higher quality SP standard had been accepted by all major networks in Australia, but at that stage no orders had been taken for the MII — in spite of the latter's introduction three years earlier.

On the GEC/Matsushita display at the Conference was a healthy array of MII equipment, including a camera/recorder and a stand-alone camera front end. The Matsushita people admitted that Betacam SP had quite a lead in sales, but felt their system was still doing well, and they considered there were unique benefits in MII.

At the time NHK in Japan were operating 200 VTR units for recording, editing and telecast — plus another 40 units for satellite and local relay work.





Above: The interior of Panasonic's AU-65. A studio VTR for record-replay and edit functions. Opposite: The interior of Panasonic's AU-63 studio player, showing PCB area reduced by 40%. Benefit is lower production costs and associated user economies.

And NBC had taken delivery of a total of over 1000 assorted pieces of MII gear, timed to cope with the Seoul Olympics. It may be relevant to mention that the 1988 cost of a basic MII setup, including two cameras and post production equipment got into the A$150,000 zone.

For many companies this path offered a fairer gamble than the newly arrived high tech, but high cost, digital path — a single Ampex digital VCR was then costing in the region of A$140,000. But the production industry is now in downturn mode, with almost every type of television broadcast material appearing in reduced quantities — commercials, documentaries, drama and so on. Only corporate video productions are in growth phase.

So, the price of equipment is a factor of some importance — not only for replacement reasons, but for those companies upgrading or investing in new installations.

Suddenly, MII has become very attractive. When you consider that a camera front end and a recording back in the format can be purchased for around $20,000 — nearly half the cost of Betacam SP — the figures take on an attractive lustre.

'New generation'

But it's not merely a price-cutting, 'maim the opposition' exercise — Matsushita/Panasonic has actually redesigned major areas in the equipment: PCB surface areas have been reduced by 40% with the inclusion of 20 new types of dedicated LSI chips.

The result is lower production costs, reduced power consumption, less weight, increased reliability and less maintenance.

Performance is up too, claims the company. The 'before and after' figures are revealing — see Table 1.

In terms of acceptance, like meat patties squashed into bread rolls, Japanese cars *et al*, what we in Australia embrace, consume and use is no guide to practices in major and more technologically advanced population centres in other parts of the world.

Often, to our shame, we tend to think that what we accept as a standard is what every one else takes on board. To the contrary. In broadcast terms, we have often embraced a single standard, ignoring the benefits of other, competitive ones.

Back in 1986 Michael Sherlock, executive VP of NBC operations and technical services, was quoted as saying "You'd think the last thing we needed was another tape format. Ah, but that's the paradox. What we needed were fewer formats and that's the 'big deal' about MII."

Sherlock went on further to explain that the attraction of MII was its 'universality':

"There's no further need for 1" equipment, or 2" cart machines; no further need for 3/4" equipment; no further need even to consider a composite digital machine."

Floyd's choice

In 1990 we were blessed with the presence of British quaffer and gourmand Keith Floyd. Slipping easily between restaurant and vineyard, Mr Floyd and his production team shot a batch of episodes of his TV series in MII format — reportedly chosen by the Producer-Director for its high level of image capture quality.

GLOSSARY

Betacam:
A broadcast format developed by Sony, using 1/2" video cassettes. The video signal is recorded at six times the speed of consumer VCRs. Essentially, it uses two tracks — one carries the Y signal, the other the C signal. Two audio tracks are also provided. Betacam SP employs a metal particle tape and uses a recording method with a higher bandwidth.
ENG:
Electronic News Gathering is any type of fast, portable electronic image capture — mostly used in news gathering.
EFP:
Electronic Field Production — generally refers to remote production techniques away from the studio, using portable TV cameras and recorders. Mostly used in documentary, programme and commercial work.
D1, D2:
The D1 standard uses 19mm tape cassettes. It digitally and separately records the three components that describe the colour television signal. This brings a benefit that is not provided by the conflicting encoding schemes of PAL, NTSC and SECAM.
Further, a higher chrominance bandwidth is maintained, assisting picture manipulation in post production. D2 uses the same cassette, but employs a composite (Y and C) signal recording method — although still digital in nature. It is capable of 20 generations of copies with no visible degradation. Cost of equipment and tape consumption is lower than D1.
EBU address track:
Specified by the European Broadcasting Union, for the PAL standard. EBU code allows the recording of absolute addresses showing hours, minutes, seconds and frames. This allows frame-accurate editing, forming the basis for automatic multi-event editing.
VITC:
A time code that is converted to video information and recorded in the vertical interval outside the area of picture information. Circuits convert this to a monitor-readable code.
LTC:
A time code recorded on an audio or other track. Most time codes — SMPTE, EBU — are recorded in this manner.

Panasonic VCRs

Keith Floyd aside, most TV viewers were probably unaware that NBC's coverage of the '88 Seoul Games was executed with MII. Every event was recorded and edited on the MII format, with the help of 200 MII units belonging to NBC Sports and News departments, resulting in 180 hours of programming going to air.

Format development

Matsushita and NHK have been developing MII since 1983. The first units were shipped to NHK in 1985, the organisation deciding to use MII for EFP and on-air work, while deploying the existing Betacam units for ENG activities.

NBC, for their part, decided to adopt the format as a long term plan to replace all of its 'on-air' cartridge playback machines, 1" VCRs and 3/4" VCRs — the benefits perceived were advantages of maintaining a single format, and MII's technological superiority. In response, Sony delivered Betacam SP.

MII was developed around the advantages of metal particle tape. By contrast, Betacam SP was developed to maintain Betacam compatibility and the latter's use of cobalt/ferric tape.

Matsushita considers their format is the superior one for a number of reasons:

MII uses a 44-micron track width; Betacam uses an 86-micron width. As a result, the Betacam SP cassette has to be 1.85 times larger to provide the same 90 minutes of running time.

Signal to noise: Admitting that a wider track contributes to lower S/N figures, Matsushita claims this is balanced by MII's use of the amorphous head design. The result is that the two formats exhibit virtually the same S/N figures.

The video signal is recorded on a pair of tracks. One track carries Luminance (Y), the other Chrominance (C) information. Since it is extremely difficult to separate the two signals completely, a portion of the Y signal is mixed with the C signal — and vice versa.

This mixed component produces a noise factor on playback and when encoded back to a composite signal — due to jitter in the VCR. In order to completely eliminate this noise and produce a satisfactory composite signal, MII uses VISC (Vertical Interval Subcarrier Control).

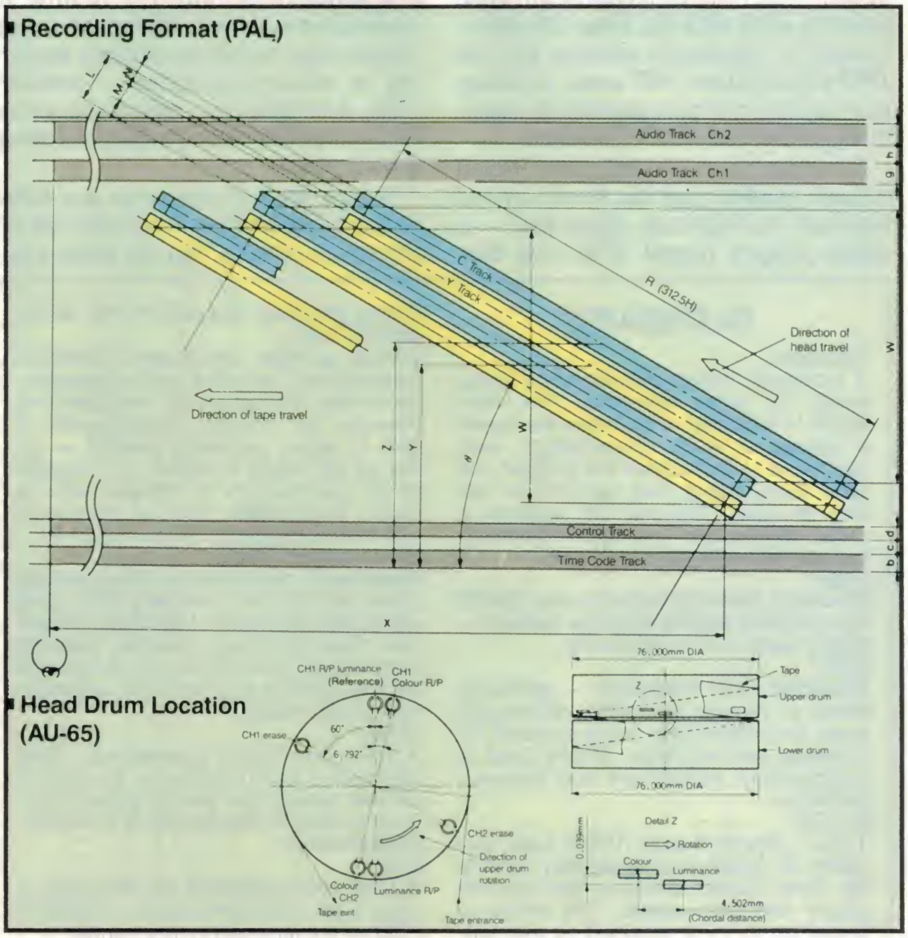
This method generates a vertical subcarrier (VSC) that is locked to the burst signal of the input signal; in PAL terms this is inserted into the 12th line.

Other tracks are recorded on the tape:

The AU-520 portable MII recorder weighs 7kg without cassette and battery. It provides a 97 minute record capacity.

the outside track at the bottom of the tape receives an EBU5 'time code' address track; above this is the control track, carrying sync information for the rotating head; the two top tracks carry audio — either as separate data, or as a stereo pair.

In addition there are two tracks not shown in the diagram: these are a stereo pair recorded across the video track area



Schematic of the MII recording format.

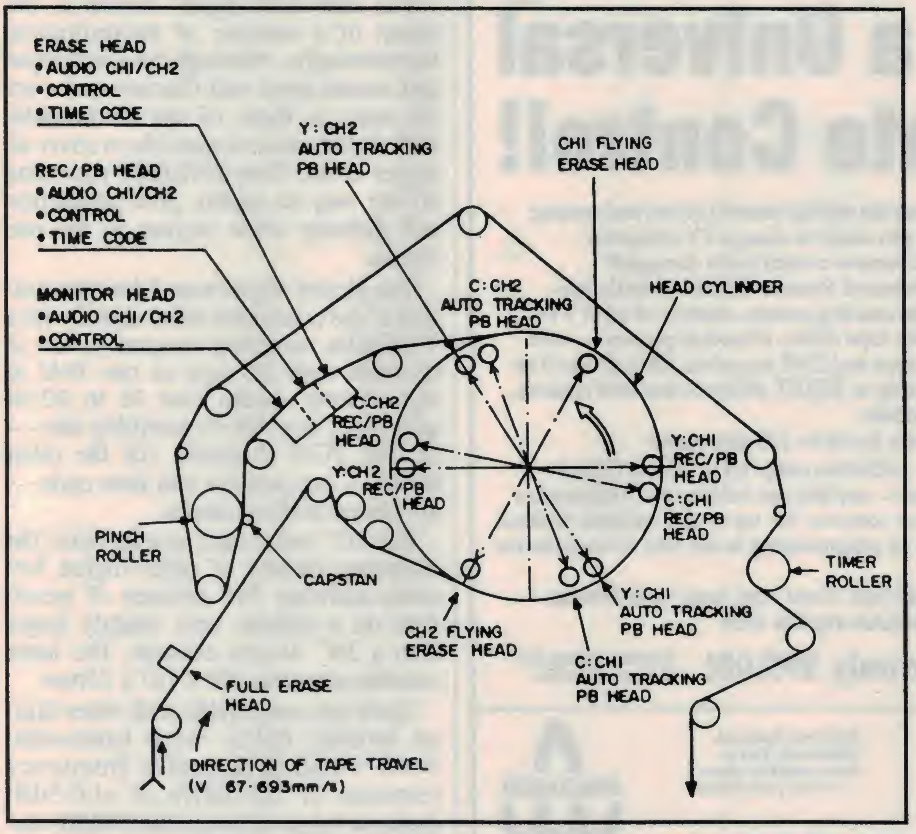
The WV-F350 is Panasonic's newly announced three chip camera, dockable with most VTRs including Betacam and S-VHS.

using the embedded FM technique. In component video recording, Y and C signals are recorded onto a separate track.

But picture jitter can occur when the signals on the tape are played back: the phase relationship between the Y and C signals is disturbed and image instability results. MII uses a burst signal method to correct the phase difference, eliminating the jitter, and producing a stable output signal.

Global MII use

At this point in time an impressive 18,000 MII units have been shipped worldwide — to organisations such as NHK, NBC, Thames TV, ORF in Austria and KBS in Korea. Many organisations use MII for on-air, EFP and for direct satellite origination.



Configuration of the MII head layout and tape path.

I've made two visits to Toei Studio's 24 stage complex in Kyoto, Japan. The first was in 1982.

As I strolled around, the paths between the stages were crowded with actors, skull-capped and ornately gowned, rushing from setup to setup. Gone for many years had been the shooting in 35mm of the frenetic samurai action movies; everything was being shot for TV — in 16mm. Quickly and cheaply, in great quantities.

Now the company's movie production is divided between film and video. Recently they introduced MII by way of a portable VTR and studio unit. Their output is now 200 samurai telemovies a year.

Toei have chosen MII because they feel its quality rivals 1" tape, and offers advantages in light weight, compactness and mobility. Locations for samurai movies are becoming an endangered species — thanks to modern Kyoto's urban sprawl.

Long hauls are becoming necessary by truck and car, plus fairly long hikes by foot to find the right mountain top or the appropriate cliff face. So lightweight gear offers distinct benefits.

Available equipment

MII equipment includes:

AU-65 VTR A studio VTR for record, playback and edit functions. The unit houses an internal Time Base Corrector, and connected to a player, enables one-event assemble edits and a full range of insert editing functions for video, audio and time code to be made. Serial interface is RS-422. The AU-65 can search at up to 32 times normal speed, forward and reverse. Jog mode is also available.

AU-62 and 63 players The AU-62 is a studio player for editing and playback. It can replay in S-Video in Y and C signals. The AU-63 is a similarly configured machine, but also provides the auto-tracking features of noiseless still and slow motion playback. AU-760 PCM studio VTR PCM sound on two channels, plus two FM and two linear channels position this unit as the top of the MII line. It also features a pair of 'pre-read' heads for PCM playback. In jog mode, the PCM tracks are audible.

Auto tracking allows noiseless still

Panasonic VCR's

and slow motion playback. It records VITC6 and LTC7 time codes, and switches between them automatically, depending on tape speed. Dual video/PCM audio heads allow confidence replay during recording.

AU-520 portable VTR Weighing no more than 7kg, this machine is for field use, and has a record capacity of from 24-97 minute capacity — depending on cassette size. For 'stand alone' use with a separate camera.

AU-410 camera/recorder Compact and lightweight, this weighs 3.6kg without cassette and battery. Can be 'docked' to a three-CCD camera, and is operable by one person. It has a 24- minute cassette capacity.

WV-F350 camera Launched in Australia this March, the F350 features a 417,000 pixel, 1/2" three-CCD image sensor. A horizontal resolution of 700 lines is delivered, with S/N ratio of 59dB. Minimum illumination figure is 32 lux at F1.4 +18dB. Outstanding detail sharpness and a low level of vertical smear is assured. The shutter is six speed — 1/50, 1/120, 1/500, 1/1000, 1/2000. The lens is a motor driven 15X zoom — 7 to 105mm.

Maybe this year?

Clearly, Australia is currently a Betacam country. But if production companies, and more importantly, TV stations see it the same way as NBC's Michael Sherlock, the MII standard could become the universal one — not only for initial vision and audio capture, but for the post production processes and final on-air transmission.

Digital format too

Quite apart from MII, Matsushita has also developed a 1/2" *digital* video format, to answer the need for an upper standard recording format — especially where such major post production tasks as multi edits or incorporation of digital effects are required.

Their reasons for choosing 1/2" were that the cassette size was considered to be easy to handle, and pocket-sized. The smallest of three measures 161 x 98 x 25mm, with a running time up to 64 minutes.

The 1/2" cassettes also offer instant adaptability from camera to recorder to playback deck to cartridge deck.

Matsushita will again be the official video equipment sponsor of the Barcelona Olympics in 1992. For this event 1/2" digital video equipment was recently developed, and will be supplied to the Games broadcast organisation.

Table 1

	First Model MII	'New Generation' MII Series
PCB area	12,000 sq cm.	7,600 sq cm.
Number of connectors	185	103
Power consumption (recorder)	360W	180W
Weight of recorder	47kg	34kg

The systems were developed by NHK and Matsushita, and will be available as studio VTRs and camera/recorder configurations. The combination of fully digitised 1/2" camera and digital VTR make very powerful tools.

Some 400 Panasonic systems will be supplied to the Games authority, and it will be the first Olympics to be covered in digital video. The advantages will roll on to broadcasters from dozens of countries, with the system's enviable asset of digital format processing.

The new 1/2" digital format is the result of a number of technological breakthroughs. Although the single input and output specs and characteristics are the same as those of the D2 format4, 1/2" digital makes it possible to cover all stages of use from ENG/EFP recording all the way to studio, post production and dubbing while staying in the one format.

The picture signal uses 8-bit quantisation of the composite video signal with a 17.73MHz sampling frequency, and is recorded onto the tape as one field in eight tracks. Audio uses 16 to 20-bit quantising at a 48kHz sampling rate — in four PCM channels. All the other tracks — cue, control and time code — are placed as linear tracks.

The 1/2" metal tape accepts twice the recording density of other digital formats, allowing 245 minutes of record time on a cassette only slightly larger than a 3/4" M-size cassette. The latter cassette measures 296 x 167 x 25mm.

Specs are comparable with other digital formats: 6MHz video bandwidth, 54dB video S/N, audio frequency response of 20-20kHz at +/-0.5dB, dynamic range of more than 100dB, distortion less than 0.01%. ■

Mini Radio Station for ACT's Erindale College

Looking for a way to enhance its 'wired' PA system for piping music and announcements around the campus, and also involve students in a 'fun' vocational project, Canberra's Erindale College built its own low power AM radio station. Here's the story of how it came about, from the teacher who directed the project and built the transmitter.

by ALEX PHEMISTER, VK1AP

Why build a radio station in a high school? For a whole heap of reasons, especially the one about it being lots of fun. But let's start at the beginning.

Erindale College is a senior ACT coeducational high school, catering for a population of between six and seven hundred students. Ages range from 16 to 19. Unlike other senior colleges, Erindale has a commission to perform as a Community College, and shares its sporting and cultural facilities with the general public. There is a well attended community education program functioning in the evenings, providing hobby and matriculation courses to adults.

Here at Erindale we have had a cable-type 'radio' service for several years, relaying music to the student common room. This was popular, and to this teacher's surprise there were always students interested enough to spend hours of their own time to provide the service. It was a fairly static arrangement, however, which seemed to many people to generate a lot of noise and little else.

A happy group at the station console. At right are announcers Ben and Alison.

For those of you who don't know, many young people take their music very seriously; indeed for many of them it becomes almost a religion. Any facility which is capable of catering to this form of worship is very important to them, and takes on the aspect of a temple, or sacred place.

You can guess what can happen if you're not careful; a power struggle for control of the holy place can develop between the many groups who consider themselves as the sole possessors of the way to musical nirvana, and this can lead to BIG PROBLEMS. Some people get so incensed that they come and knock on the door, making demands — that is, 'requests' — for their type of music. And this can play havoc with any recording that might be going on.

We now have a request box or envelope on the door, in order to cater for any urgent needs. A survey of the student body was conducted to determine overall musical taste, and the findings are used in our programming.

To inject a sense of direction into the situation, I decided that we would go into the radio broadcasting business in a more professional way. Since we had to rebuild the studio anyway, an application was sent to the then ACT Schools Authority, requesting a Curriculum Development Grant, and a DOC 57 licence application form was on its way to the Department of Transport and Communications (DoTC).

Let's look at the Curriculum Grant First. I don't know if other education systems have similar arrangements for funding innovations, but you have to find the money somewhere.

How much? We allowed $3800 for two studio quality dynamic microphones, two direct drive turntables, studio soundproofing, transmitter and antenna. We were able to scrounge from a local broadcaster and a public library a pile of oldish records, a cassette tape player, several audio amps, a CD player and about 15 CD's. That proved sufficient, when added to what we already had.

The grant was forthcoming, for which we are very grateful. We know that the money was appropriated from somebody out there who runs a profitable business. Let's hope they still do. We say most sincerely, thank you very much; we have been very careful to employ the

funds as effectively as possible. The reasoning behind our submission was that running a radio station employed most if not all of the skills that we teach in English. Let me quote from the submission:

'It is intended that the station will provide a range of educational and community services. At the college level, the preparation of students for employment in the broadcasting and television industries will be facilitated, and the generation of broadcast material of an educational nature will directly involve students in the educational process. This involvement will not be restricted to the more able students; opportunities will exist to engage students who have disabilities. A wide range of student abilities, both physical and verbal will be in demand.'

A radio station is a mixture of all sorts of things. The English component is there in the form of on-air presentation (being what we once called a 'D-J'), and the writing of scripts for plays, news bulletins, interviews, and programme production. Regular audience surveys are needed.

There is also the engineering side. The erection and maintenance of the aerial, the layout and wiring of the studio and the correct operation of the transmitter all involve some of the science and mathematics aspects of the curriculum. And it doesn't stop there. The 'nuts and bolts' students in industrial arts are needed to contribute to desk building, metal fabrication and general hole drilling. Art students can design logos, cards and posters. Music students can create station jingles and original music for broadcast.

It's a case of jobs for the boys and the girls. A radio station puts a lot of the theory into practice, and makes meaningful things that can otherwise seem rather academic. The right brain appreciates this kind of treatment, and the experience is of value when reference time comes around.

The station licence was a little different. The people at DoTC were extremely helpful, and we eventually decided that what we wanted was a Limited Radiocommunications Licence (Information Service).

Now our opinion was that a frequency on the FM band would be ideal. Good reproduction, suitable transmitter circuits abound, and the aerial is small. But this is not what you get. Like the other schools in the ACT, we were given 1611kHz in the AM band, with a power rating of five watts into a horizontal aerial — the same as the junior high school one mile away.

The prime consideration is that the station is to be used only within the recognized boundaries of the college. It's a bit hard to train the RF to do this, and we find that when both local schools are on the air there is a signal beat since the transmitters are a couple of hertz out of sync. This is only a problem out of doors, so we will live with it until I pull the crystal up in frequency.

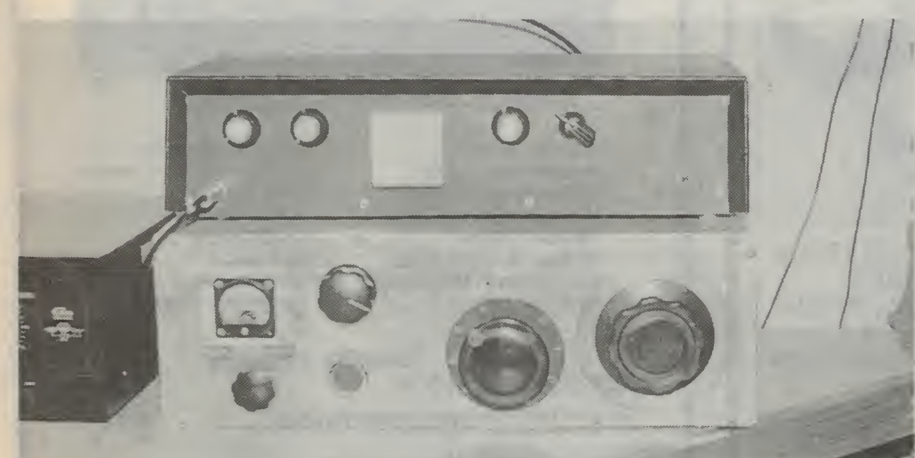
The room we use as a studio has no window to the outside world at all, and the air conditioning can be a bit noisy. Being perfectly square, about 3.3 x 3.3 metres, the studio can also set up standing audio waves, and we have installed the desk on a diagonal to bounce sound around the walls — one of which is completely covered in Sonex sound absorbent material. This arrangement works well, and the room has a friendly 'dead' feel to it.

We decided that we needed two direct-drive turntables, each with a start/stop switch, and we eventually acquired these. The mixer came from our local dandy electronics store. This has plenty of inputs, clear VU meters, a graphics equalizer, an echo facility, and two mic inputs. The only mod needed was to install two switches to turn the studio speakers off whenever the microphone slider is opened, in order to prevent feedback. These little switches are held on with superglue between the cover and the chassis proper, and are activated by the slider itself. Being two way switches, they could also be used to turn on a light indicating open mic or 'on air' status.

There are two outputs from the mixer. One of these goes to the reel-to-reel tape recorder (all programs are recorded and kept for some time), while the other is used to drive the transmitter, and for this only one channel is needed. We have a domestic type CD player, and it is quite easy to wire in an external switch to the desk which operates the pause button.

Altogether the operator has four of these little red contact switches set into the desk, each one mounted in front of the slider relating to the device being controlled — which may be one of the two turntables, the CD player, or the cassette tape player.

We also have two cartridge machines, which do not work, and several boxes of cartridges. However we are investigating the use of digital technology using the Amiga computer, and ways of recording, storing and cueing from the keyboard messages, jingles, station ID's, promos and even longer works.



The transmitter and antenna tuning unit.

Operating policy

How do you run a radio station in a school? Of course if you don't watch things closely, anything can happen and probably will. The secret is to establish Station Policy. This is based on a vision of the image that the station is to project.

At the first student meeting to establish the radio group, questions were called for. My heart sank when a close-cropped individual asked in all seriousness "Are we allowed to use swear words on air?".

My response was to ask for a definition of 'swear words'. Yep, he meant *real* swear words — none of this low-level coarse language; he wanted right-down-in-the-pit filth, with references to execution of members of the constabulary thrown in for flavour. In response I mentioned that although we need not avoid all controversy, that sort of controversy would put us off the air very quickly, and was not really part of the image that we had in mind.

It's a funny thing, controversy. Most

ACT mini station

people think it's something that involves somebody else, that they are somehow immune to its effects. The group all agreed that a little controversy would be a good thing, and would give the station publicity and attract listeners.

However when I gently banned rap music, against my usual non-censorious nature, some of them were very upset, and the issue became CENSORSHIP.

Now it so happens that I don't like rap music, and I find it hard to believe that anyone else can. Of course I am objective about these things; just because I don't like it doesn't mean I would ban it.

The reason it does not suit station policy was because a lot of it seems to contain high level coarse language, and the fact that few people seem to enjoy it, and that the people who wanted to play it soon demonstrated that they would broadcast offensive material anyway. Call me conservative, prudish, puritanical, a wowser.

("What's a wowser, Alex?" they said. Even after 12 years at school there's still plenty to learn...)

Of course many modern texts contain a lot of bad language and sexual description; some works are not considered complete or interesting unless they have this content. Films too seem to have a formula which includes references to anatomical features and digestive functions. Anything goes, you're on the cutting edge, let it all hang out (ugh!).

Well, on VJ1TX we play a little of the more refined rap music. What we play is what we have. We have some Bob Marley, lots of late-1980's pop, even Beatles and Elvis. We have lots of opera which we don't play, some Mahler and Berlioz, and Mozart which I play in my classical session on Thursday morning while I'm marking.

Keeping up to date is a problem, since we have no cash flow with which to buy records, tapes and CD's. The local shopping centre management has come to the rescue on this, and have agreed to supply a range of recorded material.

The transmitter

The transmitter took some building. I was still mentally in the valve era when I began designing it, and I received a few rude shocks about interstage coupling, among other things.

It is a basic crystal-controlled four stage transistorised circuit, and costs a lot less than the commercial equivalent available. If you are interested in this side of the project, feel free to contact me. The five watts pumped via an ATU into a horizontal random wire is not very efficient, but it works, and we are all the time improving propagation. The next step is a more efficient antenna.

At first my intention was to have a 'pure' radio station, and do away with the piped music, but the audience tends to be a bit restricted when you do that, so we combine the RF output with wired signal to the main student areas.

The material needs to be relevant to the audience, and we are still working this out. Sports results, birthday calls, topical news items, lost and found, for sale and wanted, and general gossip all seem to have a place alongside the music. It would be nice to expand our coverage to the surrounding community, but this is not permitted under the terms of this type of license.

Eventually we may apply for a full blown community licence, complete with RBT investigation, but it will cost money and time, and it seems a pity that there is not something 'in between' for people like us who wish to transmit to a fairly small area.

If you would like to set up something like our current facility at your school and you need help, don't hesitate to contact me. My address is Erindale College, McBryde Crescent, Wanniassa ACT 2603, or phone (06) 232 1210. ■

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NEW BOOKS

Radiation and health

RADIATION EXPOSURE, by Les Dalton. Published by Scribe Publications, 1991. Soft cover, 225 x 150mm, 265 pages. ISBN 0-908011-19-9. Recommended retail price $19.95.

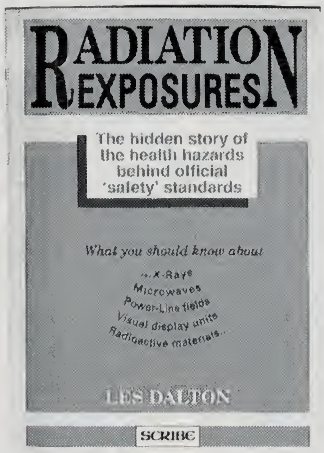
This book is divided up into three major areas: non-nuclear sources of radiation (x-rays, microwaves, power line radiation), nuclear sources (radioactive mineral water, atomic bombs and the nuclear power industry) and the health research issues (radiation interactions with our cells and genetic inheritance). It spells out clearly and starkly what we have done to ourselves by creating a complex environment with many sources of artificial radiation.

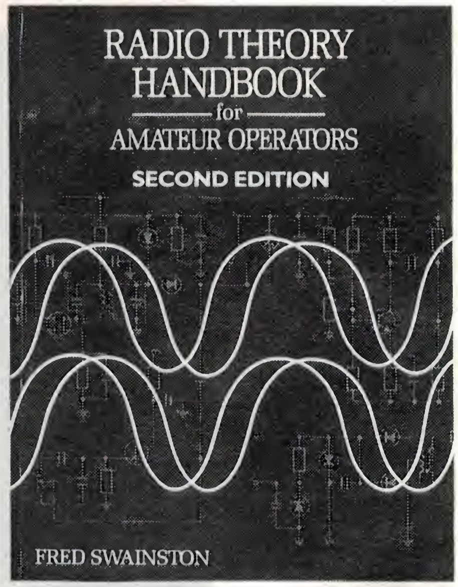
What are safe levels of radiation, and what risks are socially acceptable? Les Dalton argues that only quantitative assessment of the risks of radiation exposure has a legitimate scientific basis. Deciding upon a socially acceptable level of risk relies on unspoken value judgements about a balance between the economic and social benefits of the activities causing the radiation, and the costs to public health and the environment. He believes that this latter process should not be left to the experts.

The author retired as a principal research scientist at the CSIRO's division of organic chemistry in Melbourne in 1976. Since then, he has pursued his interests in environmental issues. His scientific background is evident in his treatment of the technical subject matter.

But the book is written for everyone interested in the topic. It does not presume any background knowledge, clearly explaining all technical terms and ideas. Where necessary, extra technical information is given in boxes: e.g., an explanation of the electromagnetic spectrum, and how such radiation is 'counted'.

Les Dalton obviously believes that many official safety standards are suspect because they reflect the attitude that, because the radiation has not been shown to be harmful, therefore it is 'safe'. Examples are quoted where already existing levels of radiation seem to have been made the safety standard, to





accommodate the status quo. For ionising radiation, he states that there is no such thing as a 'safe' dose.

All-in-all, a very disturbing book, but one which should be read by anyone interested in living in a healthy environment. It raises issues which deserve to be addressed.

The review copy came direct from Scribe at RMB 3120, Lancefield Road, Newham 3442, which can presumably supply copies either via mail order or on order from your bookseller. (P.M.)

Amateur radio

RADIO THEORY HANDBOOK FOR AMATEUR OPERATORS, by Fred Swainston. Second edition, published by Prentice Hall, 1991. Soft cover, 275 x 210mm, 359 pages. ISBN 07248 1043 9. Recommended retail price $42.95.

The Radio Theory Handbook was written to cover the Australian Department of Transport and Communications syllabus for the Novice and Amateur Operator Certificate of Proficiency. It covers all the theory necessary to pass the Department's exams.

The book is very thorough. It starts with matter and electricity and builds from there, assuming no prior knowledge of the area. It progresses logically, covering DC and AC theory and reactions with resistors, capacitor and coils. These concepts are applied to valves and transistors, along with their application in receivers and transmitters. Amplitude and frequency modulation are covered, as well as antenna design and interference problems.

The final chapters deal with test equipment, safety, practical construction and the basic mathematics required by a novice amateur.

Also included are several appendices, giving lists of symbols, Morse code, the AOCP syllabus and four sample examination papers.

The text is very easy to read and is well illustrated with diagrams. Examples of mathematical calculations are given in each chapter, along with a multiple choice test-yourself quiz for that topic.

The book is designed to provide the complete basic radio course for someone starting from scratch. It succeeds very well in this, because it is easy to read and follow, and logically works its way through the whole course, testing and revising as it goes.

It should also double as a valuable reference book, helped by a very detailed list of contents and an extensive index.

The review copy came from Prentice Hall, PO Box 151, Brookvale 2100. It should be available from your local bookseller. (P.M.)

ICOM'S IC-R72

Not long after the release of its 'mighty midget' R1 and R100 wideband receivers, which we reviewed in the October 1990 issue, Icom has come out with a new and attractively priced HF communications receiver: the IC-R72. Jim Rowe has been putting it through its paces, and here's what he found.

When I reviewed Icom's new top of the line 'DC to daylight' IC-R9000 receiver for our March 1990 issue, I described it as the closest thing to a communications receiver 'Rolls Royce' that I'd seen to date. It has virtually every possible feature and facility you could want, with a performance to match. Unfortunately, as with many other good things in life, the R9000 doesn't come cheaply; in fact at just under $8000, it's clearly outside the budget of most private individuals.

But those of us with rather more modest budgets needn't despair, for Icom has been able to take advantage of some of that new receiver technology developed for receivers like the R9000, and come up with a new general coverage HF communications receiver that offers quite a reasonable number of the same nice features, for a much more affordable price.

The new receiver is the IC-R72, which offers continuous tuning from 250kHz to 29.9MHz with AM, SSB and CW receiving modes as standard and FM via an optional add-in module. Like the two new wide-coverage receivers it's physically quite compact — 241 x 94 x 229mm (W x H x D), with a weight of 4.8kg — and also operates from either 240V AC or 13.8V DC, making it suitable for either fixed or mobile operation.

The new IC-R72 looks a little like Icom's existing and earlier HF receiver the IC-R71A, which offers many similar features. But the IC-R72 isn't meant to replace its older brother, which offers a few up-market features that the new model lacks — like a continuously variable RF gain, an IF shift control and a notch filter. Both models will be co-existing in the range, for the time being at least, with the older model still available for those who *must* have the additional features.

To be practical, though, the new IC-R72 offers just about all of the features and facilities that the majority of users would normally ever be likely to use. Tuning is fully digital, via the latest DDS (direct digital synthesis) technology, with minimum tuning steps of only 10Hz to make SSB and CW tuning very smooth and close to 'stepless'. Frequen-

cy input is either via keypad entry or the large rotary control, which can easily be set for either 10Hz, 1kHz, 2-10kHz or 1MHz steps. The receiver also offers 99 memory channels — with the ability to save that number of frequency and receiving mode/selectivity settings and then retrieve them again very easily.

Other nice features include programmable multi-mode frequency scanning; an impressive 100dB dynamic range; a noise blanker, with two selectable threshold levels; selectable 10dB and 20dB RF attenuators, which can be cascaded if necessary; a selectable RF preamp; selectable fast or slow-decay AGC; a 'control lock' button; inputs for either 50-ohm or 500-ohm unbalanced antennas; an inbuilt clock/timer; and the ability to be controlled remotely from a personal computer, via a small optional interface which connects to a standard RS-232C serial port.

Four different kinds of programmable scanning are available on the IC-R72: scanning between two programmable frequencies, sequentially scanning all programmed memory channels, scanning of only selected memory channels, and 'auto memory write' scanning where scanning is between two programmed frequencies, but the data on any 'live' signals found during scanning is automatically written into memory channels 80-99.

The IC-R72 is essentially a double-conversion superhet for AM, SSB and CW reception, with an initial up-conversion to a first IF at 70.45MHz to minimise image problems, and then down-conversion to a second IF at 9.01MHz to achieve the desired selectivity performance. When the optional FM module is added, this takes the form of a third mixer and IF/detector at 455kHz.

The set's wide dynamic range is achieved by using a pair of balanced FETs in the first mixer. For large signals this is fed directly from the antenna, via a series of diode-switched bandpass filters and the selectable switched attenuators, to minimise the risk of cross modulation. The selectable 'RF preamp' is in effect an untuned RF stage which can be switched in ahead of the mixer when needed, to lift gain and improve signal to noise ratio for small signals above 1.8MHz; it uses a pair of paralleled FETs, in common gate configuration.

The second mixer is of the diode ring type, while both the first and second IF amplifiers use dual-gate MOSFET stages. Switched crystal filters are used following the first stage of the second IF, to provide the selectivity shaping for each reception mode.

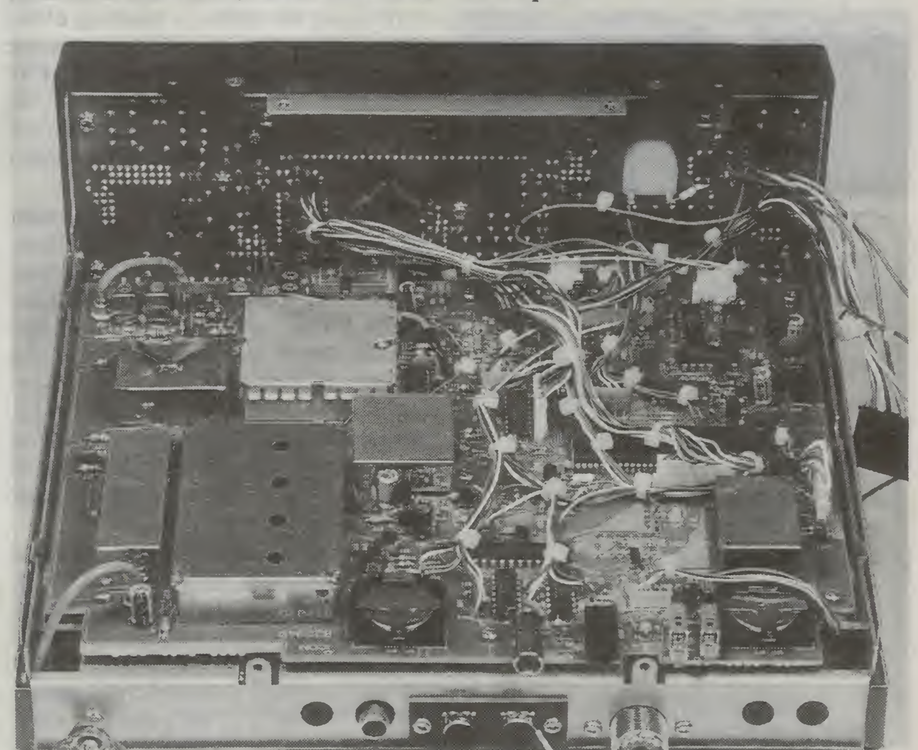
Selectivity of the basic receiver for normal AM reception is more than 6kHz for -6dB and less than 20kHz for -50dB, narrowing to around 2.3kHz for -6dB and less than 4kHz for -60dB, in the SSB, CW and AM narrow receiving modes. The figures for optional FM mode are more than 15kHz (-6dB) and less than 30kHz (-50dB), while optional narrow-band filters are also available for CW, offering either 500Hz or 250Hz bandwidth at -6dB.

The rated spurious and image rejection of the IC-R72 is an impressive 'more than 70dB'. The sensitivity for 10dB S/N ratio on AM is less than 2.0uV between 1.8MHz and 30MHz (with preamp selected), falling back to less than 12.6uV below 1.8MHz where the preamp doesn't operate. The corresponding figures for SSB and CW are less than 0.16uV between 1.8MHz and 30MHz (preamp on) and less than 2.0uV below 1.8MHz. The sensitivity for the optional FM mode at 28-30MHz is less than 0.5uV for 12dB SINAD. All very respectable and practical figures, for a modern general-purpose communications receiver.

Rated frequency stability of the receiver is less than +/-200Hz of drift in the first hour after one minute from switch-on, and less than +/-30Hz thereafter, for a temperature of 25°C or 77°F. This broadens to less than +/-350Hz over the full 0-50°C range. For those who want higher stability again, there's an optional high stability oven-heater crystal unit which replaces the existing free-air crystal in the PLL-DDS master oscillator (which also serves as the second LO). This improves the stability to better than +/-0.5ppm, between -10-60°C.

The IC-R72 has an audio output of over 2W, rated at 10% THD into an 8-ohm load. It has a small inbuilt speaker, fitted into the top of the case near the front, but also has output jacks for both an external 8-ohm speaker and headphones. As you'd expect the internal speaker is disabled when 'phones are plugged in.

Display of operating frequency, reception mode and current memory address are via an LCD display panel, with the main digits around 8mm high. The display is backlit for good visibility in poor ambient lighting, with a 'dimmer' button to throttle back the lighting if required — say for use in a vehicle. Signal strength indication is via a standard moving coil S meter, to the left of the LCD panel.

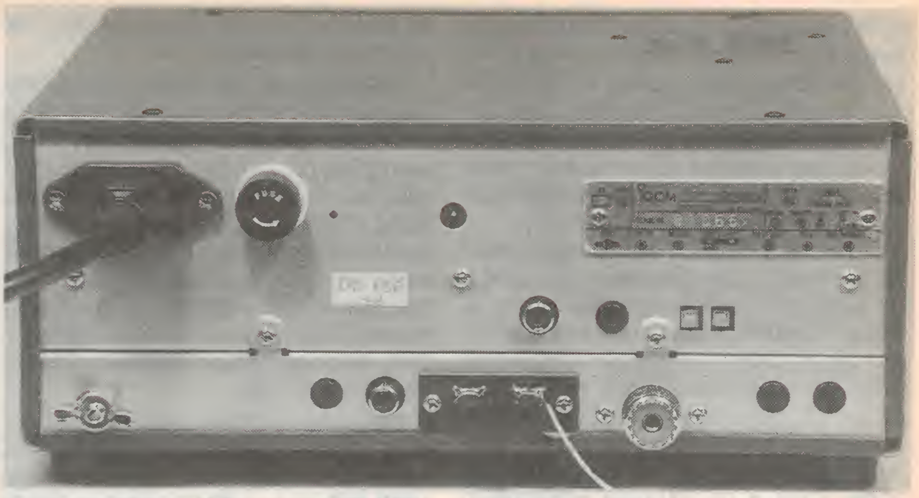


An inside view of the IC-R72, with the power supply module temporarily removed to show the upper receiver board. One of the set's two microprocessors is mounted on the front panel board, with the other visible at centre right.

Icom IC-R72

Needless to say the IC-R72 is microprocessor controlled. In fact there are *two* internal micros — one to look after the receiver's front panel, and the other to control the PLL-DDS section.

Apart from the various options noted already, Icom also has available (as options) three different kinds of external speaker (one with an inbuilt audio filter); a set of 'communications' headphones; a voice synthesiser module which announces the current frequency setting, whenever the 'SPCH' button is pressed; an 'input protector' module, to allow the receiver to withstand inputs up to +40dBm without damage; and an RS-232C level converter and cable set for controlling the IC-R72 from a personal computer. They also have a 24-hour desk clock, with a 'world time zone' face.



A rear view of the receiver, which will operate from either 240V AC or 13.8V DC. It has both 50 and 500 ohm antenna inputs, and also features a data interface which allows remote control from a personal computer.

Trying it out

I tried out the sample IC-R72 in a typical suburban listening situation, with both a 'random long wire' antenna fed into the 500-ohm input terminals, and a 15m balanced dipole fed into the 50-ohm input via a tapped balun. It gave a very good account of itself with both, although as you'd expect the balanced antenna gave consistently better results in terms of effective signal to noise ratio.

Generally speaking the receiver seemed to have excellent sensitivity, especially above 1.8MHz where the RF preamp can be used, and delivered a good signal to noise ratio on all but the most weeny signal. The selectivity provided for each of the main receiving modes also seems a good compromise for general monitoring work, especially as you have the option of selecting either normal or 'narrow' in AM mode, to cope with crowded band conditions. For CW enthusiasts I'd recommend one of the optional narrower IF filters, though; the 2.3kHz bandwidth really isn't optimum for serious CW work.

Checked against WWV and other standards transmissions, the dial calibration of the sample set was within spec, although this means it does wander around a little with changes in set and ambient temperature — in the order of a few tens of hertz, after the initial warmup. (How critical we all tend to be, nowadays!) The TXCO option would no doubt reduce this significantly, if it is likely to be a problem, which in most cases it probably won't be.

The two-level noise blanker seems to be quite effective, while the selectable input attenuators and switchable preamp give quite reasonable control over overload and cross-modulation, where you're in a band crowded with strong signals. Inevitably it isn't quite as good in this respect compared with what you'd get with a tuned RF stage and fully variable RF gain control; but for the money it seems a good compromise, and for most general listening it should be fine. In any case, a good antenna tuning unit would probably go a long way towards improving things.

In terms of operation, the IC-R72 is a real pleasure to use. It's very easy to key in frequencies via the keypad, while the rotary control is smooth in operation and easily set for any desired tuning resolution. It's even provided with a 'brake adjustment' screw, to set the desired rotary tension, and of course with a 'lock' button to freeze all settings. Very nice.

Saving settings to a memory channel is a real breeze; you simply select the next available memory location, and hold down the 'memory write' button for a few seconds when you're ready to save the settings. The receiver gives three 'beeps' to indicate that the settings have been stored. Retrieval is just as easy, while setting up for scanning is only a little more complicated.

All in all, I found the IC-R72 an excellent little performer. It provides the latest 'state of the art' performance and convenience provided by DDS frequency synthesis and microprocessor control, combined with all of the features and facilities required in a good modern general-coverage communications receiver. And all for a very reasonable price, too: the quoted recommended retail price for the basic unit is only $1368, and you might even be able to pick it up for a little less.

My thanks to Duncan Baxter and Bob Wiley at Icom Australia for the opportunity to try out the sample IC-R72.

Further information on either the IC-R72 or any other Icom receiver or transceiver is available from your nearest Icom dealer, or direct from Icom Australia, 7 Duke Street, Windsor 3181; phone (03) 529 7582. ■

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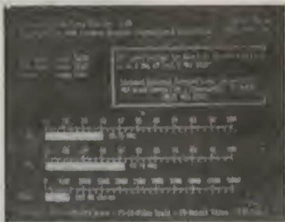

You've seen the *Landmark Speed Rating* advertised by many major PC manufacturers, now you can have your own copy of the **Landmark System Speed Test**™. Accurately measure CPU, math, and video speeds to *make an informed purchasing decision*, determine the best PC for the job or maybe just win some bets in the office on whose PC is *really* faster! Includes the Landmark AT CMOS RAM Setup program to update your system configuration *on-the-fly*.

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With **AlignIt**™ you can *clean, diagnose, and align* your floppy drives in minutes *without* a scope. Patented technology requires only a screwdriver to perform ANSI-accurate alignments (.3 mil).

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80% of all floppy drive failures can be fixed with AlignIt so don't replace your drive, save time and money instead.

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Don't replace your motherboard, don't call service, use **KickStart 2**™. When serious hardware problems occur, nothing gets you up and running as fast. KickStart 2 *measures power within 2.5%* on all four voltages, *shows Power-On Self-Test* (POST) failure codes, and features *on-board ROM-based diagnostics* allowing you to *determine and remedy the problem quickly, easily, and inexpensively!*

Built-in serial and parallel I/O *allows for testing via modem*, or simply logging results to a remote terminal, printer or laptop. You can configure your own test routines and store them in KickStart 2's battery backed-up CMOS RAM saving valuable setup time. Includes serial and parallel loopback plugs and Landmark JumpStart AT ROM BIOS for testing PCs that don't issue POST codes. KickStart 2 *tests your system regardless of O/S (even UNIX).*

On-board switches, LEDs, and digital displays allow complete control over testing in systems lacking video or disk (ideal for motherboard or system burn-in).

KickStart 2 is the *ultimate SECURITY CARD* too! With both supervisor and user levels of password protection, you can prevent unauthorized use of your PC and accidental running of destructive tests.

"KickStart 2 system diagnostics board helps users check out virtually every aspect of a PC's hardware system... the board is a worthy investment for computer maintenance." David Claiborne, PC Week - December 24, 1990.

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Need an *inexpensive solution* for dead or problematic PCs and motherboards? Try **KickStart 1**™ or **JumpStart ROM POST**™, two quick and easy to use debugging tools.

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KickStart 2 is ideal for permanent installation. It eliminates the need for an I/O card, provides remote and on-site diagnostic capabilities for quick repair time and offers a solid hardware based solution to unauthorized access with impenetrable password protection.

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PC Probe allows you to *increase your hard drive data transfer rate* by determining optimum interleave and changing it, *prevent catastrophic data loss* by performing data revitalization, *reformat* the hard drive, *run external programs*, display and edit CMOS RAM on-the-fly, *prevent accidental hard drive data destruction* with passwords, *diagnose problems with device drivers installed.*

The 200 page on-line manual has built-in table of contents, *topic/text search*, and troubleshooting tips. PC Probe comes with dual size floppies and 9 & 25 pin serial/parallel port loopback plugs. For PC XT, AT, 386, 486 and compatibles using DOS 2.0 or higher.

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Get the most out of your software, manuals and computer magazines, buy The Computer Glossary and become a true **POWER USER**. Runs under DOS or MS-DOS 2.0, or later, with 32K of RAM and 1.4 MB of hard disk space on IBM PC, XT, AT PS/2 and compatible computers.

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Landmark/SuperSoft **Service Diagnostics**™ is ideal for professionals requiring the *most exhaustive diagnostic* test capabilities. Each module is CPU specific, including PC, XT, AT, 386/486, and PS/2. Since 1981 major manufacturers like Wang, Xerox, Prime, Sony, DEC, NEC, and NCR have relied on Service Diagnostics to tackle their toughest operating problems.

Intended for professional service and repair technicians, Service Diagnostics is also *easy to use* for the novice. Clear, concise on-line help and intuitive menus make finding system problems a breeze. Tests all CPUs, math chips, all memory, floppy, fixed and non-standard disk drives, standard/non-standard printers, system board, video, com ports and all keyboards. Utilities include low-level reformat, log bad sectors, edit bad sector table; the partition editor allows you to set up multiple partitions; *back-up program* transfers hard disk image on unformatted floppies and allows for *restore* after reformat.

Ideal for UNIX and other operating systems, the *self-booting version* doesn't require DOS. The manual offers troubleshooting tips to the component level. Also available in a complete Kit including; all CPU specific software, dual size floppy alignment software (see AlignIt), and PC/XT & AT ROM POSTs. ***Winner of the PC Magazine Editor's Choice Award in August 1990.***

"SuperSoft's Service Diagnostics: The Kit is a technicians dream, with all the tools necessary to accurately analyze all phases of computer operations... It is well worth its performance potential." Bill O'Brien, PC Magazine - August, 1990.

PC MAGAZINE EDITORS' CHOICE

READER INFO NO. 12

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Moffat's Madhouse...

by TOM MOFFAT

Images of life, violence and erotica

Instant global communications are now a reality. We can put a satellite dish anywhere and transmit pictures through it to anywhere else. We can use electronics to manipulate images in any way we like. Special effects turn the impossible into a scene as real as life; much of what we see on the movie or television screen these days is 'manufactured' by electronic manipulation. We can just about make anything appear to be anything else.

Special effects these days almost always means violence of some kind. Violence sells tickets, gets bums on seats. Over the past few years the top grossing films have been the ones with the most violence... the Rambos and the Terminators and the Freddies. The most significant electronic development of our time — television — abounds with violence. Many programs seem to exist solely as a vehicle *for* violence.

On a recent Friday night the ABC ran a film made especially for television by the American Home Box Office organization, about some plot to assassinate Gorbachev. The whole thing was dull and wishy-washy until the last five minutes, when it erupted into a violent, blood-and-guts shootout. I guess that last five minutes was the film's reason for being, and you had to sit through an hour and a half of boredom just to get to the 'good bit'.

The next night, on 'The Bill', an English police series, guns were shown for the first time on that series as far as I can remember. A crim was depicted menacing police with a shotgun, and then one of the police 'stars' shot the crim. The rest of the program was devoted to the cop agonizing over what he had done, and the police investigation into the shooting by one of their own, and the implied shame of this copper in the eyes of his colleagues.

My 12 year old son, an avid viewer of The Bill, was surprised at all this. What's the big deal? He thought cops shot people all the time as a matter of course. Just a routine part of their duties. He learned this from Television. For kids, I suppose, television is their window on life, their version of reality.

Well, people DO die on television, in real life (is that a contradiction of terms?). It's enough to cause nightmares.

I still have visions of one scene I saw on television news, of a Kurdish refugee falling down a mountainside, arms and legs flailing, obviously dying in obscene agony. Other Kurds were slowly climbing down the same mountain. Nobody gave him a second glance. The camera didn't attempt to follow him. He was just part of the scenery. Just another death.

Around the same time, a scene of a Kurdish mother carrying her dead baby, stopped from burying it by soldiers because nobody was allowed to step off the road. Or other scenes of people dying of starvation, of a man shedding his last scrap of dignity to grovel at the feet of a soldier for one bite of food. This, my friends, is real life violence.

Should this stuff be shown on television? In the first case, fictional violence, I would surely like to see it stopped. It gains us nothing but cheap thrills, and makes our kids think it is a normal part of life. As for the second type, real life violence... Well, the international television networks have spent millions of dollars on direct satellite links so they can transmit live from the world's trouble spots. One can assume there were some million dollar satellite links up there in the mountain passes where the Kurds were dying of starvation, or freezing to death. The networks were obviously making a tidy profit from human suffering.

What can the viewer gain from watching people suffering? The night that guy fell down the mountain, my kids were sitting in front of the television, eating a warm meal, enjoying a warm fire. As he rolled past, the three of them just stopped in their tracks, open-mouthed and wide-eyed, obviously distressed at what they saw. It hurt them, but it hurt the Kurd more.

Many people say violent news clips like that should be banned. I say no. What my kids saw was an example of how utterly horrible some human beings can be to other human beings. And they saw the aftermath and futility of war. Maybe after seeing that they will find ways, when they're running the world, to make sure things like that don't happen again.

Back to fictitious violence: you may ban it from television, but you'll never get rid of it. You know why? Computers! It seems just about every computer game being sold nowadays, particularly for the computers that appeal to kids, is based on some kind of killing. You may 'zap the baddies' with your photon blaster, but you are still killing.

There is plenty of violence on home computers; there's even a version of Chess — a peaceful enough game, normally — in which the pieces don't just 'take' other pieces, they turn into beings with fists or swords and smash their opponents into the ground.

But the *real* champions of violence are those machines you put 40 cents into. My own son was addicted to one milk bar game in which opponents on the screen tore into each other with a collection of weapons, culminating in a battle to the death with meat hooks. That game has now been replaced — by swapping an EPROM — with another in which the combatants slash each other with executioner's axes.

The sad part about these machines is that, unlike watching a violent film, the kids are in control of who chops whose head off or who gets gored with a meat hook. All they have to do is press the buttons at the right times. It's a real education to watch the hatred that spreads over the player's face while this is going on.

In the same milk bar there is a magazine rack, complete with publications showing ladies with no clothes

on. These are carefully wrapped in plastic covers labelled 'Not available to people under 18'. Yet these same kids, 12 years old and under, can step over to the video game machine, insert 40 cents, and indulge in an orgy of killing and destruction. Is this the way our society should be?

In my own youth we watched films of cowboys blasting away at Indians, and the Indians rolling off their horses, dead. I never liked those films all that much, but I watched them because everybody else did. There were never any surprises, just cowboys (the good guys) killing fleeing Indians, because that's what cowboys did. Looking back, that attitude was just as stupid as the present one that cops shoot crims because that's what cops do.

We of course we weren't cursed with those violent video games. In our arcades and milk bars we had pinball machines, a fairly harmless form of entertainment for which I have a passion to this very day. Many times a kid has gone away dejected and red-faced after challenging me for high score on a pinball machine.

But, I'll have to admit, as an adolescent youth, I got my real jollies from the top shelf of the magazine rack. All those magazines with titles like *American Nudist* and best of all, illicit copies of *Playboy*. I guess I've always been a lover, not a fighter, but I can't really see what harm is going to come to a young fellow from casting his eyes upon one of nature's most wonderful creations, a female human form.

This is another matter of great debate; should people be allowed access to mild pornography, nowadays called 'non-violent erotica'? Home video machines mean you don't just look at magazine pictures any more, you can see moving full-colour images of men and women doing what men and women do. Feminists rage about 'exploiting the female body' but in most of these films it takes two to tango.

Distribution of this stuff is carefully controlled, and sometimes banned. But there's a source of mild porn that so far has outwitted the wowsers: the good old home computer, yet again.

If you dial up any bulletin board today you're certain to find a section devoted to '.GIF files'. These are pictures you can show on your computer screen, and if you've got a VGA or Super-VGA graphics system, the quality is remarkably good. The very best of these pictures look like fine-quality colour slides projected on a screen; they emit their own light, so they glow.

I have a large collection of .GIF pictures on my hard disk. Some of them you see in magazine ads for computers, like the image of a hamburger next to a can of Pepsi-Cola. Another good one is a Fiji chief in full head-dress. Yet another, a picture of some tropical fish, glowing with iridescent colours. There's an evening shot of San Francisco, glimmering as the sun goes down. Another, a simple picture of a red rose.

But within these .GIF file libraries are many pictures, sometimes identified by girl's names, which are the same kind of thing we used to ogle over in *Playboy* so long ago. Some of them are very high quality studio shots, lit by the latest umbrella flash and key lights. One particular image is of a lady named Ursula lying mostly nude, face-down on a rug. She isn't like your usual slender, perfectly groomed fashion model. She's instead more rounded, perhaps a bit broad across the beam, but certainly all woman.

Other .GIF pictures lean a bit toward the hard-core category; they look like they come from a textbook on gynecology. These are very explicit, but in my opinion much less pleasant than the pictures that leave something to the imagination. My favourite acquisition is a .GIF file called 'ELLE', a simple head-and-shoulders shot of the lovely Elle MacPherson, emerging soaking wet from the sea.

It's interesting to see how different bulletin boards handle the girlie pictures. One local BBS comes up with a message saying any 'porn' must be specifically requested from the SYSOP (system operator). But if you then browse through his .GIF files you'll see there is more porn there, on free offer, than anything else.

On another BBS there is a a display of how many times each file has been downloaded, right next to the file name. In the .GIF file area, the ones downloaded two or three times are the landscapes or pictures of flowers or space shuttles. The ones downloaded ten times are the girlie pix. It's interesting to note that the more tasteful shots are much more popular than the totally explicit ones.

All right, so we're all a bunch of dirty old men, setting up our own computer peep shows. But is anyone being harmed by it? No. Will it harm our kids? No. I'd certainly prefer my kids to browse through my .GIF files than to spend 40 cents murdering people on a video game screen. These pictures, be they Elle or San Francisco at sundown, are a good antidote to Sylvester Stallone or sad images of mistreatment of the Kurds.

For a long time there were two advertising billboards in Hobart showing the lovely Elle, reclining in the brand of underwear she was selling. Right there on public view! Disgusting! But I'll bet I wasn't the only red-blooded male to drive a little out of my way to go past them.

And now, right there on page 12 of this morning's *Hobart Mercury*: the fashion page... not one, but three photos of Elle MacPherson, with the main one showing her in her 'Bendon's Camille balconet bra and bikini'.

Oh Yum! and Yabba-dabba-doo! That gets the blood flowing on a cold winter's morning. The paper's probably got some complaints by now, from the same people who complained about the billboards. No doubt they'll also complain about the .GIF files, when they find out about them.

Well, folks, Elle got my day off to a good start, and I'm sure there are men all over Hobart who will say the same thing. That photo probably began life as a colour transparency. Maybe it will eventually make it onto one of the computer bulletin boards. Let's hope so! ■

THAT'S RIGHT, by arrangement with leading distributor Obiat Pty Ltd, we have THREE superb new Philips Series 90 'ScopeMeter' handheld test instruments, to be won by lucky subscribers to *Electronics Australia with ETI* over the next three months. There are two model PM95 ScopeMeters, and one top-of-the-range Model PM97 — giving a total prize value of $7344!

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The Model PM95 provides all of the features of the basic ScopeMeter, plus additional measuring cursor and recording facilities. The Model PM97 then adds further memories for waveform and control setup storage, plus back lighting for the LCD display, an inbuilt test signal generator, and an RS-232C serial interface for remote control and transfer of waveform, measurement and setup data to a personal computer or printer. Truly an outstanding handheld test instrument!

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To enter, simply fill out the coupon attached and send it with your cheque, money order or credit card details (card type, card number, expiry date and signature) to: Federal Publishing Company, Freepost No.3, PO Box 199, Alexandria 2015. Any enquiries can be made by phoning (02) 693 9517. Unsigned orders cannot be accepted.

1. The competition is open only to Australian residents authorising a new/renewal subscription before the last mail on August 30, 1991. Entries received after closing date will not be included. Employees of the Federal Publishing Company and Obiat Pty Ltd, their subsidiaries and their families, are not eligible to enter. To be valid for drawing, the subscription must be signed against a nominated valid credit card, or if paid by cheque, cleared for payment.
2. South Australian residents need not purchase a magazine to enter, but may enter only once by submitting their name, address and a hand-drawn facsimile of the subscription coupon to Federal Publishing Company, PO Box 199, Alexandria NSW 2015.
3. Prizes are not transferrable or exchangeable, and may not be converted to cash.
4. The judges' decision is final, and no correspondence will be entered into.
5. Description of the competition and instructions on how to enter form a part of the competition conditions.
6. The competition commences on 29.05.91 and closes with the last mail on 30.08.91. The draw will take place in Sydney on 03.09.91 and the winners will be notified by telephone and letter. The winners will also be announced in *The Australian* on 06.09.91, and a later issue of *Electronics Australia*.
7. The prizes are: Two Philips Model PM95 ScopeMeters, each valued at $2274, plus a Model PM97 ScopeMeter valued at $2796 — total value $7344.
8. The promotor is Federal Publishing Company (ACN 000 237 598), 180 Bourke Road, Alexandria NSW 2015. Permit No. TC91/0000 issued under the Lotteries and Art Unions Act 1901; Raffles and Bingo Permit Board Permit No. 91/0000 issued on 00/00/91; ACT Permit No. TP91/0000 issued under the Lotteries Ordinance, 1964; NT Permit No. 91/0000.

THREE of these superb new handheld ScopeMeters to be won by lucky EA subscribers!

FORUM

Conducted by Jim Rowe

More on TV transmission formats, and 'component' versus 'composite' video

As I noted last month, there were still a couple of further letters with interesting comments about the points made by Keith Walters in the April issue, regarding the relative advantages of traditional PAL and NTSC television formats compared with the various MAC formats, for satellite transmission. Here are the letters concerned, plus another with further comments on fancy audio cables.

There certainly seems to be a lively interest among *EA* readers in satellite TV and transmission formats, judging from the response to April's column. So many letters came in following that column that I was only able to print some of them last month, leaving a couple to be covered this time round. Here they are, then, and my apologies to the readers concerned for the delay.

The first letter came from well-known technical writer Stewart Fist, whose own excellent articles on many aspects of video and communications have appeared not only in *EA*, but also in quite a few other local journals. Stewart has made quite a study of the subject concerned, and also has a good deal of direct practical experience in the motion picture and television industry. So his comments are well worth reading, as you'll find:

I can't resist putting my oar in on the Forum discussion on B-MAC and HDTV.

I must say that Keith Walters' arguments about MAC television systems are appealing — mainly, I suspect, because he confirms my suspicions about the end quality of a system that has one or more composite sections in a component production/transmission system. I could never see how the claimed advantage of component systems was possible while there were composite weak links in the broadcast chain.

However, no mention was made of the MAC system's relief from the 'herringbone moire' (cross effect) that dogs PAL and NTSC systems. When luminance and chrominance are separated in time this doesn't arise, and this would certainly constitute a major improvement with MAC. But most of the improvement we are likely to see with MAC will come from satellite distribution — a clean signal with no multipath problems.

Mr Walters skips over the value of 16:9 aspect ratios in a throw-away paragraph, but I would suggest that this is of prime importance in the future — far more so than any supposed benefits to be gained from 1250 lines or increased (relative) horizontal resolution. It is the aspect ratio that viewers will want, not increased resolution.

In most cases, our present PAL TV sets already offer a vertical resolution that is higher than viewers can absorb, simply because they sit too far back from the TV set. In terms of vertical resolution, the furthest point at which I can still distinguish individual pixels on the screen appears to be about one metre, which is three times the screen height. Adjusting for the Nyquist limit, this means that the furthest point at which the maximum vertical resolution can be seen by the eye is about two metres. The Kell factor doesn't come into play here.

On my home set, most of the family watch from between three and five metres. So we aren't even seeing the full resolution presented by PAL at present — horizontally or vertically.

The idea of line-doubling on the TV set to create 1250 lines from 625 simply shifts the point at which the individual lines/pixels are discernable — in towards the screen to a distance of 1.5 times the vertical height, without effecting the vertical 'image' resolution at all. Line doubling allows bigger screen sizes to be viewed from closer, without us being irritated by line or pixel structures, but it makes no difference to image resolution or line noticeability from normal viewing distances.

The HDTV promoters constantly confuse the issue here, and they con technical people easily, because we all race up close to HDTV screens and marvel at how fine the line structure is. Customers buying sets in a store do much the same — they view the screen from ridiculously close distances, and make judgements on this basis.

The technical confusion comes from the fact that we use the term 'lines' in relationship to horizontal and vertical resolution in totally different ways. Horizontally we want to resolve the maximum number of 'image' lines, resulting from the highest end of the available bandwidth. In the vertical plane we want the 'scan' lines (more correctly pixels, these days) not to be resolved at all — it is the 'image' resolution we want maximised. In the vertical plane of conventional TV, the line resolution and image resolution are closely related, but with line doubling techniques there's a 2:1 discrepancy.

For this reason, most of the 1000-1250 line 'high definition' systems aren't high definition at all, in the 'image' sense. HD- MAC is a 625 'image line' system with line doubling. It also has some extra information shoved into each duplicated line from a digital augmentation channel, under the control of motion compensation circuits.

But, since there's only one million bits available over this channel every second, and lines are repeated at a rate of roughly 15,000 per second, then only about 60 bits of information are available to upgrade each 'doubled' line.

This isn't enough to give any real image information. At the best it can identify a block (16 pixels) of screen area that has been calculated as moving, and provide a measure of how far, and in what direction, to move this block. This doesn't improve picture resolution (which is only apparent on stationary images anyway), but only smoothes out the motion.

My real point is that in a normal view-

ing room, true high definition (1000 image lines) is unnecessary anyway, because the eye can't handle 600 lines at the normal viewing distance. HDTV only achieves some practical value if we are talking about very large screens — say one metre high, which at 16:9 aspect ratios makes them nearly two metres wide. This is a machine about twice the size of my current refrigerator (which measures 1.65 x 0.65m) lying on its side, and I can't see my wife agreeing to that in the lounge room.

I agree that large LCDs are a bit of a furphy also, but for different reasons. People forget that LCDs will have to be mounted flat against a wall, and this forces a format arrangement of seating, like in a cinema.

I don't think people want their lives or their homes to be dominated by large electronic gadgets like this. The trend is towards less television, rather than more. And our whole emphasis is 'casual' viewing, not formal seating arrangements and special viewing rooms.

So the ideal set will probably provide extended definition (EDTV), 16:9 aspect ratio 625-line images which accommodate the wider screen ratios of modern movies. You can line-double in the set if you want to, and it would help reduce large-area flicker if screens were refreshed 100 times a second instead of 2 x 25. But these are all functions that can be built into the receivers, and have nothing to do with the transmitted signals.

Thanks indeed for those comments, Stewart. You certainly deal with interesting aspects, and rather differently from the other correspondents. Rather than get too involved in the 'composite versus component' argument, with the implicit assumption that we're inevitably headed towards HDTV, you've chosen to go 'back to basics' and look critically at the kind of system most of us really seem to need or want, in a typical home viewing situation.

It's interesting the way most of us have chosen to view our TV screens from a distance of around 2-3m, isn't it? As Stewart Fist points out, with the screen sizes that have been current until very recently, this is not only too far away for us to be able to discern the line structure of a standard 625-line picture, but also beyond the point where we can make out the smallest details that can be conveyed by the horizontal resolution of the system — when everything is working optimally.

You'd almost think that we've all made an unconscious decision about the largest size we wish to view a picture on our standard TV receivers, in terms of visual solid angle, wouldn't you? Perhaps it has something to do with the fact that in a typical receiving situation, things are generally *not* adjusted to give optimum picture quality — there's usually some kind of minor ghosting, ringing or noise visible. That would explain why we all tend to watch from a bit further away than theory would suggest, if we were to be able to make use of the full transmitted resolution.

Stewart seems to be assuming that we'd all continue to sit the same distance away from the screen, even if we had an HDTV that offered much better resolution and overall quality to match. And of course if we did, the whole point of changing to such a system would be lost. Perhaps he's right, too. Of course we *might* all start to sit closer to the screen, or be happy to put up with a big screen on the wall and a more formal cinema-type viewing environment.

After all, we're happy to accept the more formal situation when we visit the cinema, and to view a picture that subtends a significantly larger visual solid angle. Presumably this is because the picture we view there *is* generally rather crisper and of higher resolution.

And yet somehow, like Stewart I can't see us all crowding in closer to our HDTV sets, assuming they have pictures of roughly the same size as current sets. Nor can I see us all rearranging our lounge rooms into formal home cinemas, with a great big screen dominating the room (and ourselves) from one end...

It's a bit of a chicken-and-egg situation, isn't it? Current TV pictures are of a certain quality, so we tend to want to view them at a corresponding distance. Whether or not we'd view them from a closer distance, relative to their size, if their quality was increased, remains to be seen.

I tend to agree with Stewart that in many ways, it's the 16:9 aspect ratio of proposed EDTV and HDTV systems that seems more important that the higher definition as such. I can remember a demonstration of HD-MAC that he and I both went to early last year, at the Sydney Opera House. The demonstrations included sets with both standard 5:4 and wide-aspect 16:9 screens, and if I recall correctly, displays of standard PAL, B-MAC and HD-MAC material. But all pictures were presented on direct-view CRT sets with screens of roughly normal size — even the sets with 16:9 pictures still had screens with a diagonal size of only around 70cm or so.

As I recall, we both had much the same reaction: that at normal viewing distance, the apparent *resolution* of the HD-MAC pictures wasn't dramatically better than that of the PAL sets. But the sets with the 16:9 'wide screen' pictures seemed to have much more impact than those with the standard aspect ratio — even those that were displaying 'enhanced wide format' 625-line pictures.

In other words, it wasn't the fact that the HDTV sets were showing us images with higher resolution that was impressive, because we really couldn't see the difference at normal viewing distances; it was more the wider picture format.

Different angle

Anyway, let's pass on to the remaining letter, which came from Mr John Barber of Hawthorn in Melbourne. Mr Barber works in the television industry as a videotape editor and computer animator, and gives us an idea of the pro's and con's of various video formats as seen from the day-to-day operational side of video programme production:

Like your correspondent Mr Walters, I am firmly of the opinion that the choice of MAC for AUSSAT primarily benefited the manufacturers of the system. I remember before the AUSSAT decision was made, how it was being touted that decoders would cost \$200-\$250. When they were finally released (with a market monopoly), it was about \$2000.

From my understanding of things, the networks were not the ones necessarily in favour of B-MAC for encryption purposes. In fact the broadcast standard encoders would have proved to be very expensive. I may be wrong, but I understand that at least one network uplinks to AUSSAT in PAL, albeit with an encrypted digital audio signal (along with other in-house data).

You pointed out some of the benefits of component video. From my point of view, component offers real, immediate benefits in the production area. For example the editing suite I use has three expensive 1" composite VTRs, vision mixer and digital effects units. We also have a small computer animation device, which generates a component signal which is recorded on a releatively cheaper component Betacam SP unit. The replay picture quality from an SP Beta is far better than the PAL signal recorded on a far more expensive composite machine.

However if the Beta SP is set to record a composite signal, which involves internally decoding into the luminance and chrominance components, then the signal deteriorates far more rapidly than it would by being recorded on a C-format composite VTR.

This all goes to prove part of Mr Walters' point regarding the constant decoding and encoding of composite PAL signals. By doing so the signal deteriorates far more quickly. The same can be said for D2 (composite) VTRs — these really only serve currently as a drop-in replacement for C format. Their strength is in the partial removal of problems with the recording medium (tape dropouts), no generation loss on (digital) dubbs, plus extra audio channels. However the tape itself is much more prone to damage if handled, or roughly treated by a faulty machine.

D2 involves digitising the picture signal at a data rate of four times the subcarrier frequency, into an 8-bit word. Like most devices which digitise composite video signals, they are prone to noticeable artifacts on replay. Far from D2 machines selling like 'hot cakes', they are not yet popular in TV stations, and only a minority of production houses use them.

D2 machines have been promoted as 'transparent' and 'like a piece of wire'. I use a number of other digital effects devices which are also 'transparent pieces of wire', and I have found them to be excellent at softening pictures and introducing noticeable digital artifacts. This has proved to be very useful in simulating satellite NTSC images for a popular TV satire show, but is not helpful for regular productions.

PAL is proving to be a major limiting factor in the type of sophisticated production and post-production effects required nowadays. Much of my time is involved in coaxing the best out of VTRs, pre-empting the problems I know PAL will cause, minimising generations and finely 'tweaking' various machine parameters to minimise generation losses, picture shifting etc.

My personal preference for a production environment is of course D1. The British manufacturer Quantel has aggressively pursued this format and has some delightful production tools like the HARRY unit which edits, paints and manipulates in component digital (CCIR 601) format. Other manufacturers also produce D1 machines, like Sony (D1 VTR), the American ABEKAS disk recorder and Bosch VTRs.

As the D1 production environment is entirely digital, numerous generations can occur with minimal quality loss. Being also a component format, high quality chroma keys, re-painting and colourising effects are easy to perform. In short, D1 is the ideal production tool for complex jobs, while PAL is still an eminently suitable transmission medium for the finished product. D1 is however very expensive, and only high-end production houses possess them. My employer unfortunately will not yet buy me one!

I am also confused by Mr Walters' reference to the problems of NTSC running at 59.94Hz, as opposed to 60Hz. I don't think it would matter a bit to a standards converter manufacturer as to which frequency they chose. I believe NTSC is 59.94Hz to avoid some harmonics, or similar, with the 3.58MHz subcarrier.

As for high definition TV, I think both popular formats are not quite there yet. I have seen demos of both the 1250/50 (1275?) and the 1125/60 systems. The resolution is wonderful. However wouldn't it be nice to couple the higher line resolution of the 1200-line European system with the 'less flicker' frame rate of the 60Hz Japan/USA system?

Of course with HDTV all the data compression and other 'cheats' they use to reduce the bandwidth of the signal will eventually reduce the picture quality — maybe to that of good PAL?

Ideally optical fibre will be the delivery medium for HDTV, with no data com-

pression or similar methods which affect the signal. Then we can look forward to some really good piccies.

All in all, the debate over 'component' versus 'composite' is not that simple. Component is a terrific production medium when used properly, and PAL is a suitable transmission medium. The problem is in the mixing and matching, and as long as the weakest link in the chain is PAL composite then PAL is the obvious transmission medium. Component however will offer noticeable improvements immediately, when used as a production medium.

Thanks for your comments too, Mr Barber. It was interesting to see which aspects had priority from your position at the video production 'coal face', as you might say.

Some of the points Mr Barber raises have already been covered, of course, and there's probably no need to cover them again. Neville Thiele explained last month why PAL is not the best choice for satellite FM transmission, due to its susceptibility to low frequency colour noise, and hence the reason for preferring a MAC-type system with sequential transmission of the luminance and chrominance. We've also seen that it *is* possible to change from composite to component video in the production chain, in an evolutionary manner, without necessarily degrading the transmitted picture quality.

Digital formats

It is interesting to hear Mr Barber's reactions about the relative performance of D2 'digital composite' and D1 'digital component' VTRs, and also his praise of the Betacam SP 'analog component' machines. Although not directly relevant to the original subject of satellite transmission formats, his comments certainly seem to support the idea of an evolutionary move towards component operation, especially where the video must undergo a lot of processing.

From memory I think he's right about the reason for the NTSC system's field rate having been moved to 59.94Hz from the original 60Hz, too. Perhaps Neville Theile or another expert can confirm this, but I believe it was to ensure that the luminance harmonic 'bands' neatly interleaved with the 3.579545MHz colour subcarrier and its sidebands, to minimise interaction.

Finally, I think I should comment about Mr Barber's first point, about the cost of B-MAC decoders and whether or not we can blame this on the effective monopoly by B-MAC's developers.

For a start, the price quoted is really not that of the decoder alone, but for the complete satellite receiver which takes signals from the block downconverter and delivers decoded video and audio. If one were to buy a separate B-MAC decoder (assuming they were available, and there were compatible receivers to suit), presumably it might well only cost around $200-300.

Mind you, this $200-300 would certainly be additional to the cost of the basic satellite TV receiver, as currently used by viewers in say the USA or Japan. So at the very least, this would be the 'premium' we're having to pay for the improved reception quality.

How much this premium depends upon the 'monopoly' aspect of B- MAC is hard to say. The prices being touted for complete D-MAC receivers and antennas in England (before the Sky/BSB merger) certainly seemed rather cheaper than the equivalent of A$1600- 2000, but perhaps this is due to the much higher production volumes that were envisaged over there.

Like Mr Barber and some of our other correspondents, I've never been particularly keen on the 'monopoly' aspects of B-MAC. But my impression is that the relatively high cost of Australian satellite

receivers is due mainly to the small production volumes that have been involved to date, because of the Government's restrictions about who can receive satellite TV and for what purpose. With such tiny volumes, only one manufacturer has been interested in making the receivers, and neither of the usual cost reduction mechanisms (economy of scale and competitive pressure) have been able to operate.

I understand that other local manufacturers were given the opportunity to make B-MAC receivers under licence, but that in view of the limited market none of them were interested.

So in many ways, it seems more likely that we should blame the relatively high price of the receivers on the Government, and its decisions to limit satellite TV broadcasting, than on the B-MAC decoding technology monopoly.

Of course if we hadn't chosen to pioneer B-MAC, but instead opted to wait for one of the systems used by other countries, such as D-MAC, we might have ended up with cheaper receivers — due to the fact that we'd probably be able to use those from Europe or Japan. Being a pioneer can also be expensive, especially if others decide not to follow your lead...

Audio cables

To round things off this month, I just have room to present a short letter that turned up with some comments on the subject of fancy audio cables, in response to the letters presented in the March column. It comes from Trevor Wilson, of Rage Audio in Hurstville NSW, who is very active in the Ozfi group and has a lot of experience in the field of very high quality audio. Here's what Trevor has to say:

I am a trained and qualified audio technician, and as such have spent the best part of the last 20 years using test equipment for evaluating all forms of hifi equipment. There have been many times where test equipment does not tell me the whole story. Audio cables is an area where listening tests seem to reveal far more than objective tests.

Please be aware that high quality cables are probably only going to make a difference in high resolution systems. These systems are probably not available to the vast majority of EA readers. I would therefore expect that few would hear any significant differences in cables.

Some points A.H. Freeman may like to take note of, whilst designing his test rig, are as follows. His dummy loads should have the following characteristics:

1. A load impedance dipping to around 0.5 ohms resistive.

2. Severe inductive and capacitive effects.

3. Be able to produce large back EMF effects (inertia related).

4. All of the above to vary with frequency and level.

Yes, it would be easier to use loudspeakers!

I have measured many loudspeakers whose impedance dips to around 1.5 ohms. Several models I have measured have an impedance dip to around 0.5 ohms. Most electrostatic models (except the Quad ESL 63) exhibit this effect. One dynamic speaker I am aware of has an impedance dip to 0.3 ohms! (Probably the result of poor crossover design.)

Please note that the human ear can detect phase differences in the order of 10us. Skin effect tests and the associated group delay problems should take this into account.

I do not agree with the bizarre advertising claims promoted by Cardas Cable. It cannot be denied that it is very good cable, though. It probably sounds good due to its sensible construction — i.e., good quality copper, individually insulated strands, PTFE insulation and very stiff overall construction. These are all hallmarks of what I have found to be good sounding cables.

I am very disturbed by the genuine lack of scientific method suggested by the contributors in the March column. We should be searching for new ways of quantifying the effects of different cables, not automatically assuming that large numbers of listeners are loonies.

There is a very simple method available to determine if there is an advantage in using high quality cables or not. That method is simply to LISTEN to them, on a very high quality system. To that end I would like to invite several skeptics to a demonstration of these cables. I will supply several pairs of calibrated ears, the venue and the equipment.

Thanks for those comments, Trevor. I don't recall anyone suggesting that people who could hear the differences between various kinds of cable were 'loonies'; just that there seemed to be an awful lot of marketing hype, and that the auto-suggestion factor might lead many of us into believing we could hear a difference, when in other circumstances we wouldn't.

Interesting test

Still, it would be interesting to see the results of conducting a series of double blind A-B comparisons, using top quality equipment and some well-trained ears. If you get a chance to arrange some tests along these lines, I'd certainly be interested in the results — or even observing the tests.

I doubt if I'd be much good as a test subject, though. From the tests I've carried out myself, including some with the high quality Ozfi gear, my ears don't seem to be acute enough to hear the subtle differences you're talking about.

And with that I think we'll end up this month. I have a couple of letters rounding off the subject of electrical safety, ELCB's and so on, but there isn't the room to present these properly so I'll leave them for next time. ■

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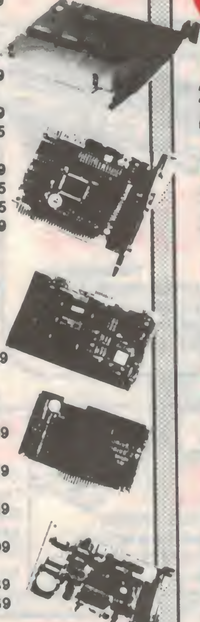

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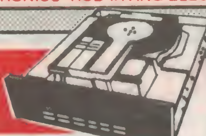

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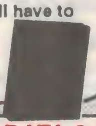

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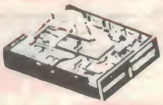

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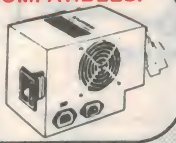

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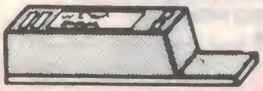

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X14955...................................$169

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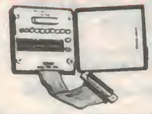

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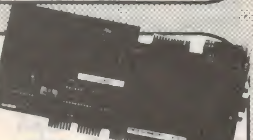

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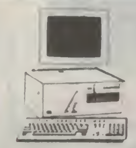

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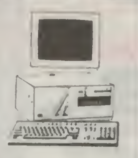

80286-16 CPU
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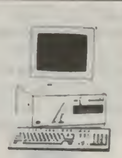

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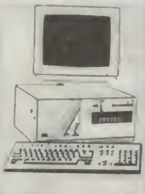

80386SX-20 CPU
1 MEG RAM EXP TO 4 MEG
27Mhz LANDMARK SPEED TEST
1.2M JAPANESE F.F.D
42M HARD DISK DRIVE, 28ms ACCESS
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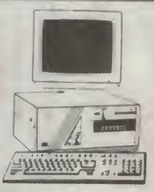

80386-25 CPU
CACHE ON BOARD 1 MEG RAM
32Mhz LANDMARK SPEED TEST
42 MEG HARD DISK 28ms ACCESS TIME
1.2M JAPANESE F.D.D
101 EXTENDED "CLICK" KEYBOARD
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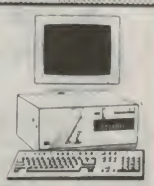

80386-32 CPU
128K CACHE ON BOARD MEMORY
1 MEG RAM EXP TO 16 MEG
57 Mhz LANDMARK SPEED TEST
42 MEG HARD DISK 28ms ACCESS TIME
1.2M JAPANESE BRAND F.D.D
101 EXTENDED "CLICK" KEYBOARD
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56Mhz LANDMARK SPEED TEST
43 MEG HARD DISK 18ms ACCESS TIME
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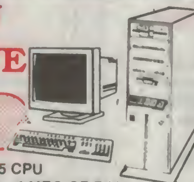

80486-25 CPU
ON BOARD CACHE. 4 MEG OF RAM
115Mhz LANDMARK SPEED TEST
43 MEG HARD DISK 12ms ACCESS TIME
1.2M JAPANESE BRAND F.D.D
3.5" 1.44M JAPANESE BRAND F.D.D
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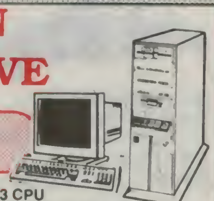

80486-33 CPU
ON BOARD CACHE. 4 MEG OF RAM
157Mhz LANDMARK SPEED TEST
200 MEG HARD DISK 12ms ACCESS TIME
1.2M JAPANESE BRAND F.D.D
3.5" 1.44M JAPANESE BRAND F.D.D
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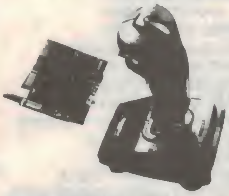

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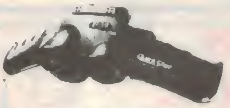

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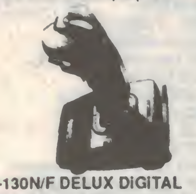

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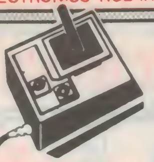

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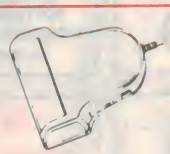

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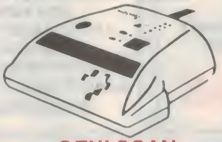

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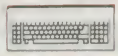

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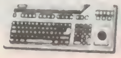

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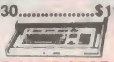

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THE SERVICEMAN

The worn idler roller that wasn't, and the dropped CD player that survived

I have two stories for you this month. One tells the tale of confusion over symptoms in a VCR, whose fault took rather longer to find than I had expected. The other is a 'good news' story about a badly abused CD player which at first sight seemed to be a 'write off', but turned out to respond favourably to my reconstructive surgery.

The video recorder job came in with the complaint that it was 'chewing up' tapes. With some models this symptom immediately concentrates the mind on one particular fault — a worn idler roller tyre. These are the 'Jam Jobs', the easy ones that put jam on the table, to supplement the bread and dripping that is all that results from the real stinkers.

Anyway, this one was an Akai VS-112, a middle-aged unit that is generally pretty reliable. This one had never been in for service in the four or five years since the owners bought it.

Their worry was not so much that the machine had broken down, but more that it had ruined a rental tape first up, then several of their own tapes while they were trying to make up their minds about bringing it in for attention. I hadn't seen this particular model previously, so before anything else, I decided to place an order for a service manual, along with a couple of sets of belts.

A belt kit for most models costs under $10, and for any recorder more than say four years old, replacing the belts is cheap insurance against a lot of potential troubles in the not-too-distant future.

In this case I felt sure that the trouble would be nothing more than a worn idler tyre and this item is included in the belt kit. So I felt that replacing the belts and the idler tyre, plus a good cleanup all over, would very likely cure the problem and restore the machine to near new condition.

I had reason to feel confident that this would be an idler tyre problem because the only other (common) fault likely to tangle tapes is a defective reel motor. And as this deck had no reel motor, instead using a belt drive from the capstan motor, it seemed that the tyre had to be the cause of the trouble. The parts duly arrived and I set about fitting them. And it was here that the job started to go awry.

I had no trouble removing the cassette carrier, to gain access to the idler wheel. But such access was useless, because the idler could not be removed from the top of the chassis. Nor could I get the old tyre off without first removing the idler assembly from the chassis.

So I turned to my brand-new copy of the service manual — only to find that it had not a single word about the idler installation. It did include comprehensive circuit diagrams, an extensive parts list, pages on tape path adjustments, electrical adjustments, head drum replacement, etc., etc. But not a word on the idler assembly removal and replacement. As far as the manual was concerned, I was on my own.

After examining the mechanism for several minutes, I decided that I would proceed to fit the belts. Then if I had not found the answer to the idler problem, I would take the whole box and dice to a friend who is more familiar with the Akai machines. I turned it over and removed the bottom cover, and I wasn't happy with what I saw.

The main circuit board covers more than half of the space inside the cabinet. What's more, it covers almost half of the mechanism, with the capstan motor, capstan flywheel and much of the idler assembly being hidden under the board.

Once more the service manual was of little help. It does show a series of photos of the machine in various stages of disassembly, but no word of how to get it into each stage. I found two clips holding one edge of the board, but releasing these was no help. Then there were four or five screws on the other side of the board, and releasing these not only freed the board, but also dropped the hinge brackets down into the works!

I recovered the brackets and spent some time working out how to reassemble everything. Once I got the hinges replaced, I realised that one of the two hinge bearings was really a slot, along which the hinge pin could be moved to allow the board to be lifted clear of the frame. (Who said one picture was worth a thousand words? Even after I knew how to unhinge the board, the picture in the service manual still didn't make sense!)

Once the board was out of the way, I was able to get at the bracket that covered the capstan flywheel, and to ultimately replace the two belts. One was a flat belt between the motor and flywheel, and the other a square section belt from the flywheel to the idler drive pulley.

It was while I was fitting the new belts that I realised that the idler assembly

was fixed to the deck with just two screws. Also, there was a pin under the idler which passed through a curved slot in the deck and was secured with a washer and the tiniest 'E' ring I have ever seen. I knew that the E ring had to be removed to get the idler out, and that was no real problem. However, I didn't like my chances of ever getting it back in place after I had changed the idler tyre!

The idler assembly was very awkward to remove, but it eventually succumbed to some gentle force and I was able to replace the tyre. The original seemed to be in surprisingly good condition, with no sign of the glazing that usually denotes a worn tyre.

I reassembled the idler into the deck, then turned it rightside up and refitted the cassette holder. With everything back in place, it was time for a test run.

You can imagine my feelings when the machine still refused to wind a tape, either forward or reverse. I carefully checked everything I had done, and hunted around for any screws that I might have left out. There was nothing amiss anywhere that I could see.

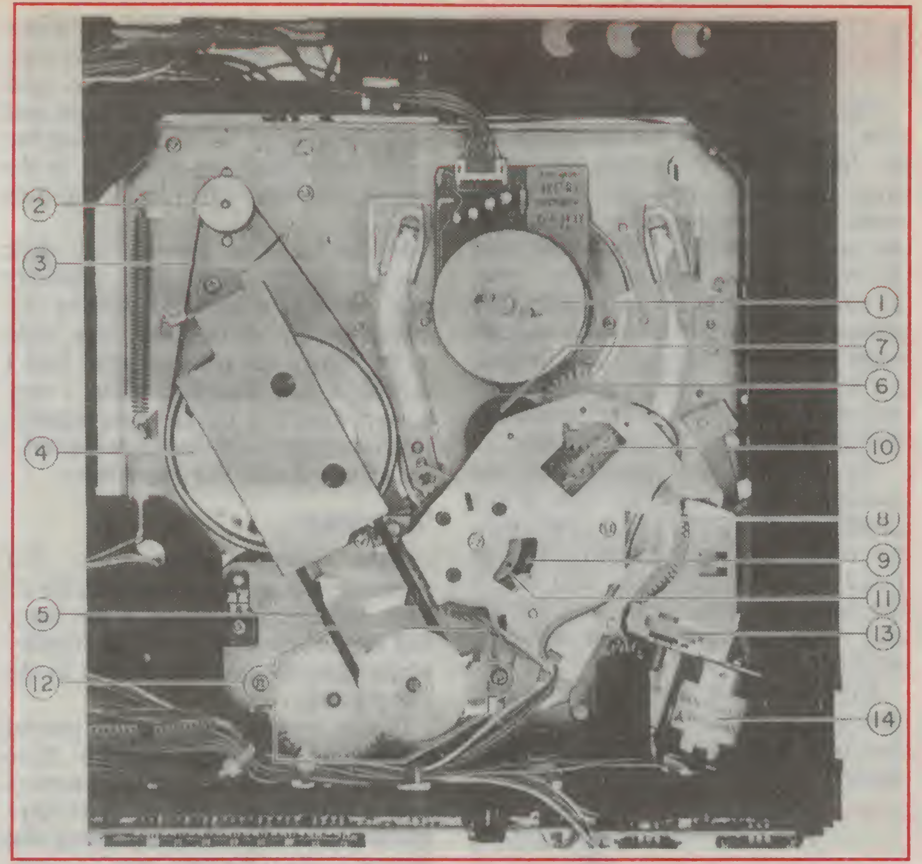
I did find one useful piece of information in the service manual. It showed how to run the mechanism with the cassette carrier removed. It simply required a fine wire loop to be fitted between pins 3 and 5 on the cassette carrier plug. After this, I was able to operate the machine in all modes without a cassette in place.

All that I could tell, after watching the machine go through several load-play-unload cycles, was that the idler was not free to toggle easily from wind to rewind. At rest, and during the play mode, the idler was lying hard down on the deck and it took quite a bit of pressure to make it move in either direction.

However, as the machine moved into the play mode, the idler lifted up clear of the deck and was then free to swing either way. Unfortunately, it didn't stay free for long enough to move into the play or rewind positions.

The idler drive in this particular model is somewhat unusual, in that it uses a geared drive and a dog-clutch, rather than the more usual friction drive and clutch.

The dog-clutch is operated by a small lever on the side of the assembly which, when pressed, raises the dog to engage the slots under the idler drive wheel. It was this lifting process which was allowing the idler a moment of freedom but the problem seemed to be that the clutch was not staying in position. It was being pushed up by the lever but was not being latched.



The underside of an Akai VS-112 VCR, the subject of our Serviceman's first story this month. The idler wheel mechanism that was the focus of his attention is at lower centre in this picture, in the section identified with key number 12.

I removed the assembly several times, in an attempt to find if there was something broken that might account for the inability to latch. In all other respects the idler seemed to be willing to work, if only it could be held in the position where it could work.

A few days later I was talking with a colleague about the problem when he pulled a complete idler assembly off the shelf over his bench. We examined the assembly carefully and I made some mental notes for comparison when I returned to my workshop.

Back at my bench I went over the idler very thoroughly. It looked to be identical to the colleague's unit, even down to the tension needed to operate the dog-clutch lever. Eventually, I came to the conclusion that the fault must lie in the deck.

There was an assembly of rods and levers between the loading motor and the idler unit which appeared to have something to do with the latching process. It certainly operated the levers around the idler when the machine was moving into the play mode.

At this point I was completely lost. There was nothing in the service manual that could help me, nor any reference to another manual that might hold the mechanical details.

Some manufacturers use the one deck in a number of different models, and only print the mechanical details in the first of the manuals. I hoped that this might be the case with this Akai, and set about finding someone who might have the much needed mechanical manual.

I began my search with the colleague with whom I had already discussed the problem. And to make the discussion easier, I took along the whole machine. I had the idea that if all else failed, I might try changing over the faulty idler assembly for the good one on his shelf.

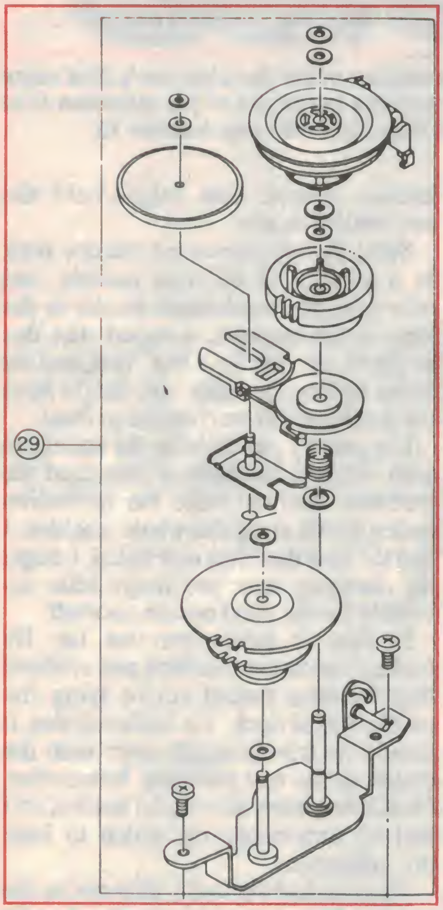
In fact, it didn't get that far. He looked inside the machine and realised that the idler should not be lying flat on the metal deck. He believed that it should be free to toggle even with the clutch in the rest position. Remember, I had never seen this model before, so I had no experience on which to base my judgement.

We soon had the faulty idler out on the bench and set about comparing it with the good one. At first we could not see anything different, and certainly no obvious reason why the idler should lie flat on the deck.

Then, looking at each unit from the side, we noticed that the clutch faces in the faulty unit were a little bit further apart than in the good one. And a moment later all became clear. The top pulley on the assembly, the one that takes the drive from the capstan motor, is free to move vertically on its spindle. The movement is part of the clutch engagement process. In the good unit, the pulley travel was limited by a clip locked into a slot on the top of the spindle. In the faulty unit, the clip was missing.

We couldn't see exactly why the missing clip allowed the idler to sag down onto the deck. But it didn't matter, really. We fitted a small E ring in place of the missing clip, after which the machine came good and played and rewound tapes with not the slightest trouble.

So I don't really know if the new idler tyre was necessary. But as I said earlier, new belts and tyres are cheap insurance against future problems. It's as well to



Reproduced from the Akai service manual, this diagram shows the idler wheel assembly. The circlip that was responsible for the problem is visible at the very top of the diagram.

remember that no matter how obvious the fault may seem, the common cure may not always be the right one. And one more point before we go on to the next story. The manual did have a drawing that might have given me a clue as to the trouble, although I didn't realise this until later.

In the exploded view of the deck mechanism the whole idler assembly was shown as a unit. The missing clip and its washer can be clearly seen, right at the top of the main spindle. Had I looked at this drawing earlier, I may have noticed that the clip was missing. But then again, I may not have noticed.

And now for the CD player story.

'It rattles'...

When compact discs were first released, we were impressed with the almost indestructible nature of the discs, and worried about the seeming fragility of the delicate optical assembly in the disc players.

In the event, the worries proved somewhat misplaced, because there are many thousands of players around and comparatively few of them have given any trouble. In fact, the story that follows is about the very first CD player to come into my workshop. That is not so surprising, because I tend to concentrate on TV and video repairs.

This particular job came my way because my son is involved with the local Public Access radio station and he recently asked if I would look at their CD player. It seems that someone had caught his foot in the power cord and had pulled the machine off the bench. I was told that it now "...won't play, and it rattles when you shake it!"

I asked if they were in the habit of shaking their CD players, but all I got in reply was a look that said my flippancy wasn't appreciated.

In due course the machine was brought into the workshop, and I confirmed that it did indeed rattle. Even handling it gently produced rattles from within the cabinet, and it was obvious that something quite large was loose inside.

My first impression was that the machine was a write-off. I don't know a lot about CD's, but I couldn't imagine that one could make this ominous kind of noise without massive internal damage. The player was a Yamaha model CD-X3, a rather basic machine and now quite a few years old. It had none of the bells and whistles that mark current models, but it appeared to be a solid, well made unit that had stood up pretty well to years of hard use — at least until the present accident. When I removed the cabinet top I was surprised to see very little obvious damage. Everything seemed to be in its place, and there was nothing that appeared to account for the rattling sounds we had heard earlier. Then I realised that my unfamiliarity with CD players had led me astray.

When a compact disc is being played, it is clamped between two padded circular plates, each about 25mm in diameter. The bottom plate is driven by the main motor and serves to rotate the disc. The top plate is attached to a spring loaded lever, which is raised and lowered by a cam on the same gear that opens and closes the disc drawer.

In this machine the clamping lever had broken loose and was turned around 180°, so that the padded disc was hanging over the back of the disc drawer.

When I picked the lever up, the whole drawer, motor and laser assembly tilted and fell back into the bottom of the cabinet. It had been caught up on one edge of the circuit board, but was otherwise completely loose inside the cabinet.

I turned the machine over to remove the bottom plate and with that the disc drawer and optical assembly fell out, to the limit imposed by the four leads that connected it to the circuit board. The leads were terminated with miniature plug and socket assemblies, too small for manipulation by my clumsy big fingers. I used a pair of miniature long nose pliers to extract the plugs, and soon had the disc carrier freed from the cabinet. Now the full extent of the damage could be seen.

For openers, the four mounting pillars that had been moulded into the main framework had broken off. That's why the carrier was loose. The broken pillars were still attached to the metal deck.

Then one of the trunions that the clamping lever pivoted on was broken, as was one of the pivot pins moulded into the clamp itself. Fortunately, nobody had opened the cabinet to see what had happened, and all of the broken pieces were still laying around inside. (I also found a tiny piece of circuit board material, with some lettering on it. I really had to search hard to find where *that* had come from!)

So that was the sum total of the visible damage, and now I had to decide if it was worth trying to make it good. This was complicated by the fact that although the station desperately needed the machine for programming purposes, they only valued it at about $100 but couldn't afford to replace it with a new machine. Like most public

radio stations, they are constantly short of money.

I think they were hoping that I'd write the machine off so they could claim on their insurance policy for $100 towards a new one. But I wasn't prepared to stick my neck out just yet. I wanted to know if it could be repaired.

I felt that the mechanical damage might well be fixed with Super Glue. My main worry was about what had happened to the optical unit and where that chip of circuit board had come from.

The first of those worries could not be tested until I had made good the broken plastic, so I decided to invest whatever time was needed to put that right. There is no doubt that Super Glue is the wonder of the age. So long as the broken parts will fit back into place, Super Glue will hold them together as strongly if not more strongly that they were before being broken.

In this case most of the mouldings were made of polystyrene, and the Super Glue held them tenaciously. Unfortunately, the one part that *needed* to be held tenaciously, the trunion on which the clamping lever pivoted, was made of nylon. I haven't yet found any glue that will effectively cement nylon. In this case the repair had to be very strong, because the trunion was under constant tension from the powerful clamping spring. As it turned out, the design of the trunion suggested the method of repair and provided the means to effect it.

The trunion consisted of three nylon tubes; two short ones and one longer one. The clamping pivot rested in a groove between the shorter tubes, while a washer and self-tapping screw on the longer tube held the pivot in place against the pressure of the clamping spring. The tubes appeared to have been moulded around the metal base plate, and had broken off flush with the metal. This left a ring of nylon on the other side of the plate.

The solution was easy. A suitably short, thick self tapping screw fitted through the base plate into the bottom of the longer tube fixed everything solidly into place. After giving the Super Glue a few hours to cure, I reassembled the deck and plugged it in for a trial run.

Would you believe, it worked!?

I was quite surprised myself, because I didn't think the optical assembly could survive a shock heavy enough to break plastic cabinet parts. I expected it to be at least out of alignment, if not actually broken.

So as far as the radio station was concerned, I wasn't prepared to write it off against their insurance. To this stage my bill would have been well under the $100 value put on the machine. All I could do was to wait until the station committee made up its mind on what it wanted to do.

In the meantime, I took the machine home and set it up in the dining room. I played a disc whenever I was at home to listen, and I soon found that there was another, more subtle fault that probably wasn't related to the breakage. In fact, my son later told me that the machine had been playing up for some time before the accident.

It took the form of an inability for the machine to find the start of a track. It happened more often at the start of track one, but was sometimes apparent on other tracks. It sounded almost as if the disc was playing fast, but was really playing snippets of music, from four or five tracks apart, in rapid succession.

And it was quite intermittent. Perhaps four times out of five it played perfectly, right from the start of the disc. Sometimes it would mis-start two or three times in a row, then it would be perfect for another six or eight starts.

I have no doubt that the problem can be cured, but until the station committee makes up its mind about what to do with it, I am not anxious to spend any more time on the job. I'll finish it off later, when and if they decide that they want it done. In the meantime, I'm telling the story here to show you that CD players are a bit more robust than we had previously given them credit for.

Not that I recommend dropping a player on the floor. But if an accident does happen, the result may not be as catastrophic as the rattling noises from inside the cabinet may suggest.

Oh, I almost forgot — that chip of circuit board. Where did it come from? It was only a flake of material from a small circuit board behind the front panel. It carried no copper tracks, and the rest of the board was unmarked, so I didn't bother about replacing it.

Postscript: The player has now gone back to the station and is filling in until they can get a new unit. They considered it not worth spending more money on further repairs.

Well, that's all for this month. I hope to have some more stories from contributors for the next issue. See you then? ■

Fault of the Month

Sharp VC-386X VCR
(also Philips VR-401)

SYMPTOM: Pronounced flutter in sound, caused by rapid variation in capstan speed. Frequently this can be caused either by a motor fault, or a bad drive belt. However in this case it was neither of these causes.

CURE: C732, a 10nF mylar capacitor on pin 6 of IC703, was defective. This is the storage capacitor for the second of two 'sample and hold' circuits in the capstan control IC. The result was a very rapid 'hunting' as the circuit tried to find the correct speed.

This information is supplied by courtesy of the Tasmanian Branch of The Electronics Technicians' Institute of Australia (TETIA). Contributions should be sent to J. Lawler, 16 Adina Street, Geilston Bay, Tasmania 7015.

When I Think Back...

by Neville Williams

Vintage radio receiver design — 3
Mains supplies usher in a new order

The late 1920's and early 1930's saw the establishment of a vigorous Australian radio industry and the emergence of a large factory-trained workforce, giving rise to a whole new generation of dedicated hobbyists. On the technical front, an initial wave of locally produced mains powered TRF receivers were superseded, in short order, by simplified but efficient superheterodynes.

In the early 1920's, many home handymen had become involved in 'wireless', primarily because it offered access to information, news and entertainment at a time when all three were in short supply — particularly in the country.

With no relevant background and limited back-up in the way of technical literature, such newcomers to the new and unfamiliar technology largely had to learn by trial and error. Fortunately, it was a relatively safe hobby in terms of life and limb.

Operating purely from batteries, receivers of the day posed no threat to unskilled experimenters. The real risk was to the equipment, with beginners all too prone to confuse the battery connections, invoking the ultimate disaster for an impecunious experimenter — 'blown' valves!

However, when the focus later shifted from battery to mains-powered receivers, the supply voltages lurking in the wiring jumped from 135 at most to more then double that figure, plus a decidedly lethal 240V AC direct from the power mains. Rather than the components being at risk, the greater concern was that a chance high-voltage encounter might 'blow' the unwary experimenter!

But while many enthusiasts have experienced salutary 'bites' from mains powered equipment, I'm not aware of any local reader/hobbyist who has paid the ultimate price for their interest in radio.

It may well be that the infusion of academically and/or industry-trained people into the ranks of radio hobbyists fostered an appropriate awareness of the need to be careful with anything connected to the power mains — a point that needs to be borne in mind by the present generation of vintage radio receiver enthusiasts.

Small AC receivers

As happened in the battery set era, designs for a whole range of elementary mains powered receivers appeared in the technical press, *circa* 1930, intended primarily for home construction. They were welcomed by the rising generation of industry-based enthusiasts who, while handling commercial receivers by day, were frequently too poor, in the shadow of the great depression, to afford anything quite as pretentious.

By courtesy of Mr H.D. Burraston of Murrarundi, NSW, I have to hand a copy of a booklet 'Modern Radio Circuits for AC Operation', issued as a supplement to *EA*'s predecessor *Wireless Weekly* for August 14, 1931. It offers very helpful glimpses of contemporary receiver design.

Fig.1 shows the circuit of the *WW* 'Direct Coupled 2', using a 224 screened-grid tetrode as a regenerative detector feeding a type 245 power triode output valve. The 280 rectifier is not included in the valve count.

(Perhaps I should also mention here that the initial digit, indicating the manufacturer was later dropped from American valve type numbers, so that they became known simply as 24, 45, 80, etc).

Guide notes in the booklet warned that the sensitivity and selectivity of such simple two-stage circuits were limited, and it was recommended only for urban use (I quote): 'within 20 miles or so of the broadcast stations'. Even so, interference between adjacent stations could still be a problem in difficult locations; e.g., close to one or more transmitters.

Compared with an equivalent two-stage battery set, husky valves and a high tension supply voltage in the range 425-450V DC could provide loud reproduction of such signals as the set could successfully tune. In an optimum situation, with an efficient dynamic (moving coil) loudspeaker, the constructor was promised reproduction to rival that available from a much more pretentious design.

Dynamic loudspeakers

Elsewhere in the booklet, readers were reminded that many existing dynamic loudspeakers were of the 'AC powered' electrodynamic type. Introduced about 1926, a step-down mains transformer and copper-oxide rectifier attached to the housing provided low voltage DC to energise the field coil.

Looking back, I recall that discarded examples of the breed were often picked over by hobbyists, in the forlorn hope that the transformer and rectifier would be in good enough shape to double as a modest home battery charger.

The next generation of electrodynamic loudspeakers (Fig.2) were less cumbersome and generally more efficient. Fitted with field coils of much higher resistance, they were capable of being supplied with current from the receiver's own HT power supply, requiring from 7 to 10 watts for adequate field energisation.

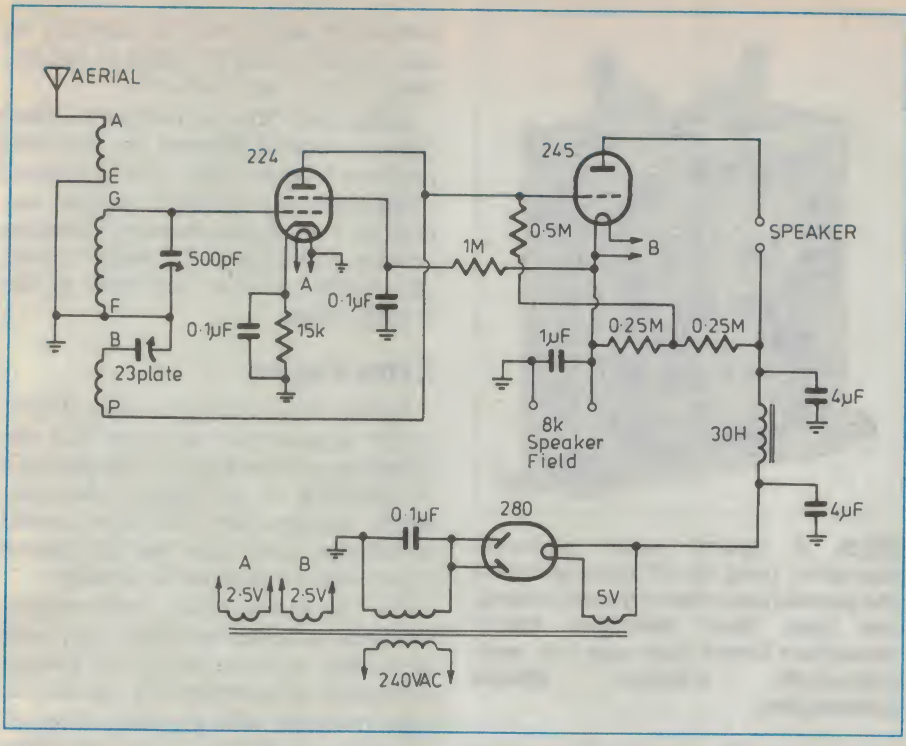


Fig.1: Redrawn from a Wireless Weekly booklet issued in August 1931, here is the circuit diagram of the 'Direct Coupled 2", an early and modest mains operated receiver intended for home construction.

Subsequent generations of Australian-made Amplion, AWA, Rola and Magnavox loudspeakers looked very much like the Jensen pictured. After World War II, field coils gave way to permanent magnets.

With hindsight, various aspects of the 'Direct Coupled 2' circuit reflect the sometimes immature technical reasoning in the transitional period between the technology of the 1920's and 1930's.

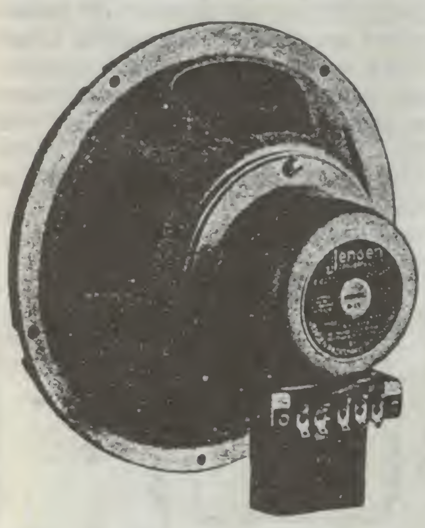


Fig.2: A then-current American Jensen dynamic loudspeaker, imported by the International Radio Company Ltd of Sydney. The field magnet is bolted to the rear of the cone, with the cable tagstrip and voice coil matching transformer suspended underneath.

Thus, while the configuration of the detector is reminiscent of the traditional Reinartz reaction circuit, there is no grid capacitor or 'grid leak' resistor. Instead, the 224 is shown as an over-biased 'anode-bend' detector — an innovation more appropriate to larger receivers, subject to possible detector overload. For a simple receiver, the traditional and reputedly more sensitive 'leaky grid' circuit would normally be a more logical choice.

The output stage

Again, the output valve is a directly heated type 245, normally requiring the hum to be balanced out by returning the negative feed from the HT supply to a filament circuit centre-tap — apparently overlooked in the circuit diagram. In fairness to the designer, use of the 45 probably has more to do with the valve manufacturers, who clung tenaciously to directly heated output valves long after all other functional mains types had been developed around sleeved cathodes.

But, to me, the most debatable aspect of the design — a carry-over from the much publicised 1920's-style Loftin-White amplifier — is the use of 'direct coupling' to the grid of the output valve from the anode of the preceding stage.

Clearly the designer of the 'Direct-Coupled 2' assumed that omission of the coupling capacitor would effect a noticeable improvement in the overall quality of reproduction.

I subsequently contested this simplistic — but not infrequent — assumption in the very first instalment of 'Let's Buy an Argument' (now 'Forum'), maintaining that the omission of a lone coupling capacitor in a simple non-feedback amplifier merely complicated the rest of the circuitry to no good purpose.

In the circuit of Fig.1, the grid of the output valve is tied to the positive potential at the anode of the 224 detector — a fact that may have influenced the choice of the anode-bend configuration.

For normal class-A operating conditions to apply, the filament of the 245 would need to be about 50V positive with respect to the grid, with the anode supply 250 volts above that again. According to the descriptive text, the design calls for a total supply in the range 425-450V — an incongruous figure for such a small set.

To obtain this voltage, the power transformer/rectifier system has to operate in half-wave mode, as shown. With a ripple frequency of 50Hz and the filtering relying on a nominal 30 henry choke and two 4uF paper capacitors (Fig.3), I do wonder about the residual hum level. (Electrolytic capacitors had yet to emerge as a routine choice for HT filtering.)

I also wonder about the presence of the loudspeaker field coil in the filament/earth return circuit of the output valve. Superficially it might appear to be a neat way of energising the field, but a complex and potentially resonant impedance in a path common to both input and output must introduce random negative current feedback around the output stage, affecting its output impedance. As well it could divert audio power from the voice coil into the field coil.

To invoke an old saying, the complications involved in eliminating one lone coupling capacitor strike me as the technological equivalent of 'straining at a gnat and swallowing a camel'.

Different approach

Interestingly enough, the same supplement offered readers a quite different 2/3-valve receiver called the 'The Hi-Power Two'. Two separate coils and two ganged capacitors provide band-pass tuning (see Fig.4) ahead of a Mullard 354V indirectly heated triode, operating as a conventional regenerative leaky-grid detector.

As a result and as distinct from the Direct Coupled 2, this alternative design

was credited with 'astounding selectivity' (for a small set) and said to be 'at its best when located right in the midst of the powerful local transmitters'.

The detector was transformer coupled to a British-based Mullard PM24A power output pentode — as distinct from the American 24/24A RF tetrode. The specified loudspeaker was again a Jensen dynamic with 8000-ohm field coil but, in this case, wired directly across the DC HT supply.

Requiring only a routine 250-odd volts, the power supply system involved a 280 type rectifier fed from a normal centre-tapped power transformer, plus a couple of filter chokes and the then routine 'Chanex' or 'Hydra' 4uF paper dielectric capacitors.

Also worthy of mention in this otherwise poor man's 2/3 valver is the inclusion of an audio volume control ahead of the output stage, and a top-cut tone control across the anode circuit. Both warrant explanation at this point; first the volume control:

In urban areas, as already indicated, a small mains powered regenerative set could provide quite high output from strong local stations, necessitating some means of reducing the sound to an acceptable level. The seemingly obvious course was simply to back off the regeneration (or 'reaction') control, but this could adversely affect the selectivity, leading to possible interference problems.

By providing a supplementary volume control, the regeneration could be set for maximum detector gain and selectivity, the volume control being adjusted separately to produce the desired sound level. While a routine procedure for a technically inclined listener, the critical manipulation of two knobs, both affecting volume, would have been potentially confusing for other members of the household.

The tone control

Most receivers up to this point in time had used triode output valves having a characteristically low output (or anode/plate) resistance; e.g., around 1600 ohms for a type 245.

In such a case, the natural frequency response of the system is not greatly affected by the wide variations in impedance which loudspeakers typically exhibit over the audio range. Hence, with a clean signal and a loudspeaker of reasonable quality, the overall sound can be relatively smooth.

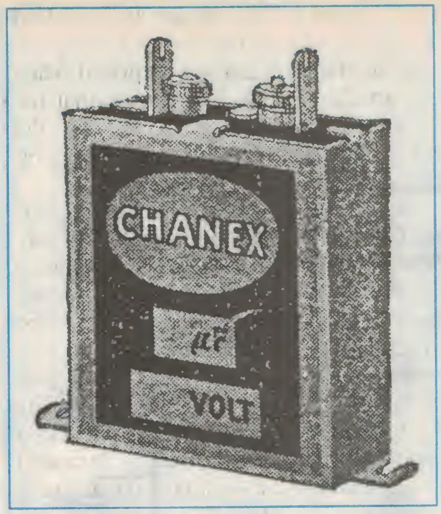


Fig.3: A typical paper dielectric capacitor, used for HT filtering before the general adoption of the electrolytic can type. Many discarded 'block' capacitors found their way into early home-built amateur station transmitters.

By contrast, power output tetrodes and pentodes have a much higher output resistance — typically 60,000 ohms in the case of a 247. In consquence, the frequency response tends to vary with the loudspeaker impedance, resulting in a rather 'boomy' quality at the loudspeaker's bass resonance and a pronounced accentuation of the upper treble. The difference between the two was quite noticeable but, while listeners tended to tolerate the extra bass as a novelty, they disliked the strident treble. Designers countered by installing a suitable bypass capacitor across the anode circuit of output pentodes, to attenuate the upper treble response. Indeed, translating a vice into a virtue, they commonly provided a potentiometer in series with the capacitor so that the tone could be varied at will between 'bright' and 'mellow'.

In fact, such 'top-cut' tone controls became a routine fitment on domestic receivers from the early 1930's onward, being commonly left in the 'mellow' setting. As a result generations of listeners became conditioned to 'woolly' music and muffled voices. But back to the original theme.

Extra stages

As had happened in the early 1920's, small regenerative receivers like the foregoing remained largely the province of hobbyists — of financial necessity and/or because they derived a certain satisfaction from achieving impressive results with a minimum of circuitry.

On the other hand, commercial receivers, intended for family use, were invariably of more ambitious design, less reliant on operator skill and able to cope routinely with a greater range of reception conditions. From the viewpoint of both supplier and customer, the ideal receiver was an affordable model that could be delivered to any ordinary address, connected to an aerial and power point and tuned, forthwith, to the full gamut of stations available in the area.

Fortuitously, the abovementioned *Wireless Weekly* booklet features a range of receiver designs using three, four and five valves plus rectifier — all TRFs, with one, two or three tuned RF stages ahead of the tuned detector. All feature direct coupling to the output stage, which complicates the audio circuitry. But more importantly for our present purpose, the notes document how well the respective front ends coped with the less crowded broadcast scene in 1930/31.

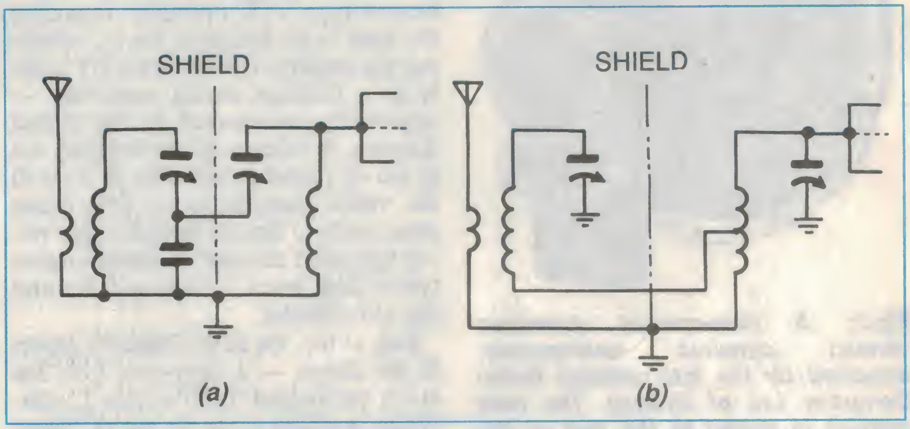


Fig.4: Double-tuned 'band-pass' circuits were often employed to improve front-end selectivity. Arrangement (b) is the logical choice when the tuning capacitors share a common, earthed frame.

Again, helpfully, a *Wireless Weekly* 'Call Sign' booklet issued a few months earlier (July 1930) lists the 33 AM broadcast band stations across the Australian continent — compared with a present tally of around 250, crowded into channels only 9kHz apart.

The *Wireless Weekly* 'Midget 3' was so called because it was fitted on to a chassis compact enough to be housed in a table-top cabinet. It used a 224 as a tuned RF amplifier followed by another 224 as a tuned anode-bend detector feeding a 245 power output triode. A 280 rectifier in half-wave mode produced the requisite HT voltage for the direct coupled ouput stage, the 8000-ohm field coil being connected across the HT in series with a 5000-ohm heavy duty resistor.

Using a 224 tetrode in the RF stage ensured much greater amplification of the incoming signal than was normally available with a triode. No less to the point, the presence of a screening electrode between grid and plate, and access to the grid via a top cap connection reduced the grid/plate capacitance by around 100:1.

This obviated the need for neutralising circuitry, the only precaution in the interest of stability being the use of metal shield cans over the 224 valves and the respective coils (Fig.5).

Significantly, the compilers of the booklet classified the 'Midget 3' as the smallest class of receiver which could offer reasonable gain and selectivity without having to rely on the use of regeneration (quote) 'which is considered objectionable by many enthusiasts'.

'Most popular' set

The sequence of small receivers leads up to what the booklet presented as the then-current ideal receiver: 'The 1930 Four', whose circuit is shown in Fig.6. It was described as: 'the most outstanding design ever known to the Sydney radio trade', for which 'more kits of parts have been sold ... than any set previously described in Australia'.

Why? Because it had unmatched tone, 'enough volume to fill a small hall' and sufficient range to give excellent interstate reception.

Another TRF design, it used two 224 tetrodes as tuned RF amplifiers, a third as a tuned anode-bend detector, followed by a Philips P443 — a directly-heated high-power output pentode. The rectifier was a high-voltage half-wave 281, fed from a 575V transformer.

The covering article indicates that there had been problems with the design, when first published, with the lower rated output pentode originally specified and with unreliable resistors. Again, with hindsight, I am not surprised when the article goes on to mention that the HT supply voltage provided for the direct-coupled circuitry ended up at around 625-650V!

Notwithstanding this, the fact remains that the two-RF stage configuration, with single-dial triple-gang tuning (C1/C2/C3), won wide acceptance as the best compromise for the reception conditions that obtained in 1930.

Not surprisingly, many contemporary commercial receivers adopted this general approach, with a 3-gang tuning capacitor and two RF stages, followed by a detector, an ordinary capacitance coupled output stage and a conventional 250-odd volt power supply.

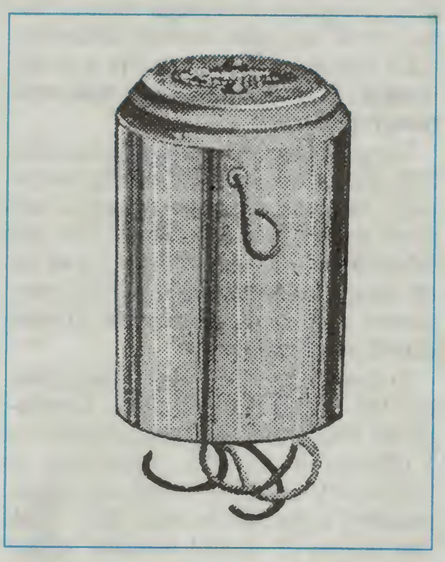


Fig.5: Manufactured by the Metropolitan Electric Co, Sydney, shielded, matched aerial and RF coils like this were available for TRF receivers, priced at 9/11d (99¢) each.

Gain or volume control

One other point about the '1930 Four' warrants special comment, namely the matter of a gain (or 'volume') control.

Because of their high intrinsic gain and consequently low grid bias, RF tetrodes like the 224 could readily exhibit signal overload effects close to one or more broadcast stations, therefore in many urban areas.

A powerful local signal could conceivably penetrate the first tuned circuit and be cross-modulated onto other carriers by the first RF stage. Even though the interfering carrier itself may be rejected by subsequent tuned circuits, its audio component could still break through as spurious modulation on other carriers. Or, again, in a larger receiver, the excessive signal level may be evident as distortion caused by overload of the final RF stage or the detector itself. Either way, a gain control in the audio system is of no help, since the overload has already occurred ahead of where the control can have any effect.

Superficially, the gain of RF tetrode amplifiers can be be reduced by simply increasing the negative grid bias — either directly or by using a wire-wound potentiometer as a variable cathode bias resistor. The problem is that this simultaneously reduces the plate current and further limits the ability of the valve to handle high level signals. Thus, only partial control is possible, with cross-modulation and/or distortion remaining a potential problem.

In the '1930 Four', the designers have opted instead for an 0.2 megohm potentiometer varying the screen voltage of the first two valves. While this was often used at the time, the idea would appear to suffer the same limitations as variable bias.

That it did so is evidenced by the fact that the design specified a 'Local-distant' switch which introduced a low value resistor (typically 10-25 ohms) across the primary winding of the aerial coil. Intended to reduce the level of all incoming signals, the resistor could be switched in or out of circuit, depending on whether or not it provided a cleaner result.

Gain control posed a problem for many medium to large receivers about this time, both TRF and superhets and, while a local-distant switch was a potential source of confusion for non- technical users, it was commonly fitted to both commercial and home-built designs as a matter of necessity.

One other point worthy of mention is the provision of a 'jack' socket (J) in series with the earthy end of the detector grid coil. For the most part ignored, its purpose was to allow a phonograph pickup to be plugged into the grid circuit of the detector so that the phono signal would be fed through the amplifier and loudspeaker.

It could be argued that a detector would not be optimally biased to operate as an straight amplifier, and that there was no provision anyway for an audio control to vary the sound level from discs.

Both observations are legitimate but, at the time, the majority of pickups were relatively crude magnetic types, and fitted with their own loudness potentiometer anyway. Most listeners were aware that electrical phono amplification was possible, but the current em-

phasis was on broadcast programs. Family radiograms did not really become 'trendy' until around 1935.

A 'deluxe' TRF

The most ambitious receiver presented in the *Wireless Weekly* booklet is The 'De Luxe Five' — or 'Six', counting the rectifier. An elaboration of the foregoing 4/5 valve receiver, it used *three* tuned RF tetrodes ahead of the 224 anode-bend detector which, in turn, drove a Philips F443 high power output pentode. The rectifier was a half-wave 281, fed with a 600V transformer. As distinct from the smaller receivers, the circuit called for an 'AC Jensen' loudspeaker, providing its own field energisation with an in-built mains transformer and copper-oxide rectifier.

Summing up the receiver, the booklet claimed that, irrespective of valve count, there was nothing that could outperform the De-Luxe Five 'except for some forms of superheterodyne'. It was particularly recommended for use in 'up-country towns' involving a range of several hundred miles, but was not recommended for major cities because 'it picks up all kinds of interference noises and amplifies them to an extent which will make reception unpleasant'.

This is an off-putting statement, to say the least, but probably confirms the fact that, at the relevant time, it was one thing to provide high RF gain but quite another to control it smoothly and effectively.

Relying on screen voltage control for the three 224 RF amplifiers and a drastic local-distant switch, the set may indeed have been unduly vulnerable to front-end overload and mains-borne RF interference in urban areas.

Front-end gain control remained an urgent problem until the introduction of 'super-control' or 'variable-mu' screen grid valves, in mid 1931. The International Radio Company of Sydney announced local release of the National Union variable-mu 235 in *Wireless Weekly* for April 13, 1932.

The variable-mu characteristic was achieved by fitting a special tapered-pitch grid, or by simply snipping selected half-turns from a fixed pitch grid.

The effect was to change the grid control characteristic such that while it appeared quite normal with low values of bias, it required a very high value of bias to cut off the plate current altogether. The abrupt plate current cut-off 'corner' in the characteristic was competely eliminated.

Virtually identical in appearance to the 224, the variable-mu 235 offered essentially the same transconductance — and stage gain — as the 224 at -3V. But whereas the 224 plate current curve cut off sharply at around -6V, the 235 plate current curve trailed out to an ultimate cut-off at around -50V.

In announcing their equivalent valve, the 335 in *QST* for July 1931, Cunningham listed the transconductance as 1.050mA/V at -3V, reducing to 0.015mA/V at -40V — implying a huge potential reduction in stage gain. With that degree of control available and a plate current curve free of abrupt corners, it became much easier for designers to forestall front-end overload with its consequent cross-modulation and distortion.

Had 235 type valves been available in time for the '1930 Four' and the 'De-Luxe Five', the designers could simply have specified them for the RF stages, arranged for variable cathode bias and ended up with much smoother control — minus the local-distant switch.

Selectivity vs quality

That aside, while receivers such as those above offered predictable gain and selectivity for the listening situation circa 1930, the industry was well aware that, as far as domestic receivers were concerned, such designs epitomised the practical limits of TRF technology. Two and three-gang tuning capacitors were acceptable, four-gangs were manageable but anything beyond that would be too clumsy and too expensive.

In any case, the selectivity curve exhibited by a TRF tuner varied unduly across the broadcast band. According to one set of figures to hand, when tuned to 600kHz, a typical receiver using a three-gang capacitor exhibited a total bandwidth of 100kHz at 60dB down. However, when tuned towards the high frequency end, its bandwidth, as a simple proportion of the resonant frequency, widened to around 250kHz.

Unfortunately selectivity was worst at the very end of the band where it really needed to be at its best — thereby comparing very unfavourably with a superheterodyne, which could provide a narrower passband which was substantially uniform over the whole tuning range. Arguing with as much spirit as characterised their later forays, audio buffs of the period stoutly maintained

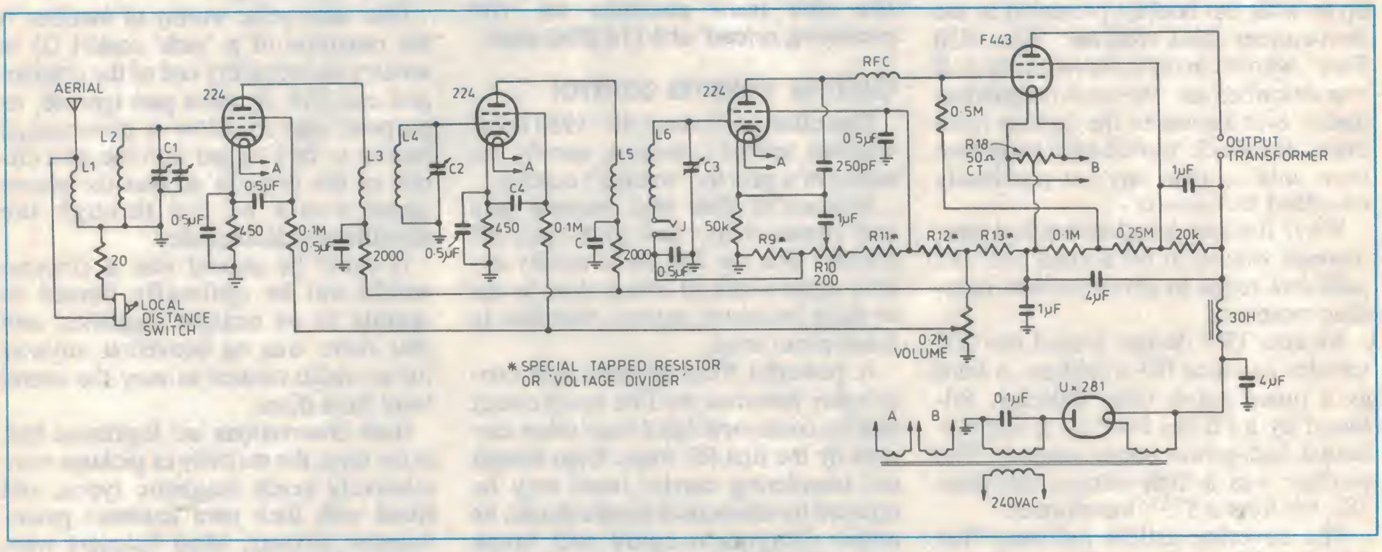


Fig.6: The '1930 Four', said by Wireless Weekly at the time to be their most popular project to date and considered to be the best current compromise between performance and cost for the average listener.

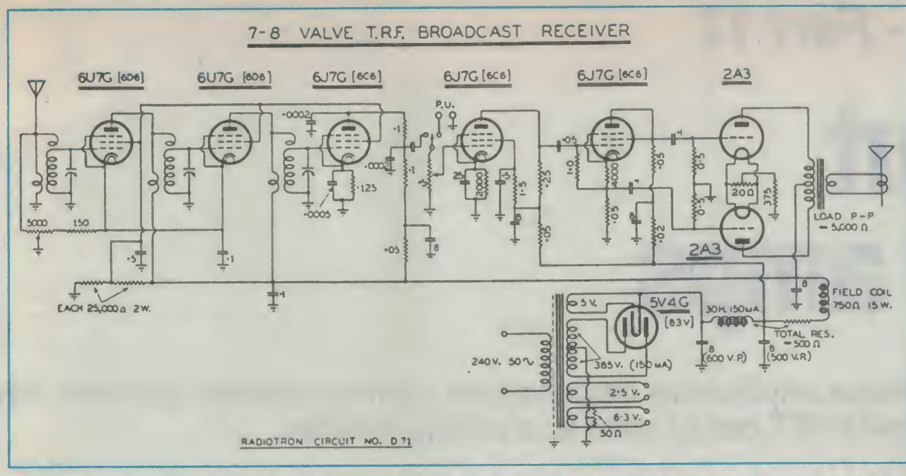


Fig.7: Designed especially for audio buffs and featured in 'Radiotronics' No.82 (1937), this receiver combined a three-valve TRF tuner with a classical push-pull 2A3 triode amplifier.

that emphasis on receiver selectivity was inappropriate; that the vast majority of families listened only to their local stations, and that extra selectivity would diminish rather than augment their listening pleasure.

Receivers with a narrower bandwidth had to be tuned with greater accuracy for minimum distortion, they suggested. What's more, they attenuated the high frequency sidebands, diminishing the clarity of voices and robbing music of its natural overtones.

The arguments gave rise to an audio cult which supported TRF receivers on principle, and equated them with 'hifi' radio reception.

In all fairness, it probably has to be admitted that the best sounding receivers of the era *were* TRF tuners with two variable-mu RF stages, an anode-bend detector and a power triode output stage. The modest front-end provided a reasonably balanced signal and the power triode(s) delivered it to the loudspeaker with much less distortion than characterised the louder — and more strident — non-feedback power pentodes.

As we shall see in the next chapter, vital design initiatives enabled the superheterodyne system to capture the mass market from 1930 onwards. But TRF tuners retained lingering support throughout the decade from specialist suppliers and audio buffs.

Fig.7 shows the circuit diagram of a TRF receiver for hifi enthusiasts developed in the Applications Laboratory of the A.W. Valve Company and published in *Radiotronics* No.82, dated December 1937. It used two tuned variable-mu RF amplifiers and a 'reflex' detector — essentially an anode bend detector with a large cathode resistor bypassed only for RF. It did not load the input circuit and had notably low distortion by reason of the cathode negative feedback. Because the design did not lend itself to AVC, the user had to manipulate two manual gain controls — one for the front end, the other for the audio system. High impedance primary windings in all coils and a capacitive coupling loop adjacent to the active end of the respective secondaries helped to equalise the gain across the tuning range. Fitted with a push-pull power triode output stage and an appropriately baffled hifi loudspeaker system, it was very much a receiver/amplifier for hifi enthusiasts of the day.

In May 1941, the Editor of this magazine (by then called *Radio & Hobbies*) the late John Moyle, presented a TRF tuner very like that used in the AWV receiver, with the idea that it could be used with an existing *R&H* amplifier using push-pull 2A3 output triodes. For sound quality, he said, the combination would be 'almost unbeatable'. A year later, in May 1942, I personally described the 'TRF Quality Six' in *Radio & Hobbies*. With parts scarce, due to the war, it was a distinctly different economy design, slanted to take advantage of possible alternative components. Since then, TRFs have been remembered mainly 'in absentia', with hifi-orientated engineers more intent on dreaming up ways and means of creating wideband or variable-selectivity superhets. Only recently, with the arrival of solid-state technology and AM-stereo has such technology come of age.

But that's much too recent to qualify as history. In the next chapter I will be looking at the evolution of 1930's-style superhets.

(To be continued) ■

Basic Electronics - Part 12

More about transistor amps

We continue our discussion on voltage amplifiers by describing the common collector amplifier, the field effect transistor (FET) and how a FET can be used as a voltage amplifier.

by PETER PHILLIPS

In Part 11 we described the common emitter (CE) amplifier, and showed that this circuit can have a very high voltage gain, depending on the values of the components. However voltage gain is only one aspect of an amplifier, and the input and output resistance of the circuit are often more important.

Because it is not always possible to get the right voltage gain, input and output resistance values using a single amplifier stage, most practical amplifiers have more than one stage. Here the first stage might give the required input resistance, the next the voltage gain and perhaps a third to provide a low output resistance.

The CE amplifier stage can provide voltage gain, while a common collector amplifier can provide a reasonably high input resistance and a low output resistance.

Another way to get a high input resistance is to use a *field effect transistor* (FET) as the active device in an amplifier. In this part of the series we describe both the common collector (CC) amplifier, the FET and the common-source FET amplifier.

The CC amplifier

We briefly described the CC amplifier in Part 11, and the circuit is shown again here in Fig.1. This circuit is very similar to the common emitter amplifier except that the output is taken from the emitter of the transistor and the collector connects directly to the positive rail of the DC supply.

Resistors R1 and R2 bias the transistor's base, and therefore establish the DC conditions of the circuit. However, this time the emitter voltage needs to be around half the supply voltage, so for an NPN transistor, the base voltage has to be 0.6V higher than this. As an approximation, as shown in Fig.2, if R1 equals R2 the base voltage will be half the supply voltage and the emitter voltage 0.6V less, which is usually adequate for most purposes.

Input resistance

The values of R1 and R2 depend on the required value of input resistance, and they need to be as high as possible

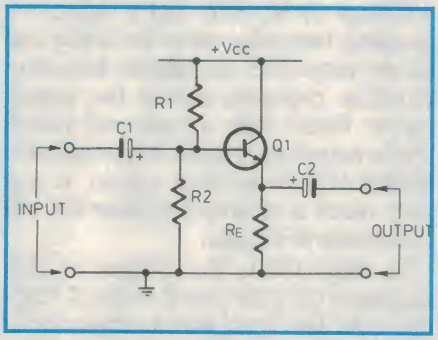


Fig.1: The common collector amplifier, in which the input is to the base and the output taken from the emitter.

for a high input resistance. As for the CE amplifier, the input resistance is approximately equal to the parallel combination of R1, R2 and the emitter resistor RE multiplied by the current gain (hfe) of the transistor. Because the output of the circuit is taken from the emitter, there cannot be a bypass capacitor across RE, although if a load (RL) is connected to the circuit, its value needs to considered as being in parallel with RE.

What this means is that the input resistance of the CC amplifier can be higher than the CE amplifier. For example, if we use the component values shown in Fig.2, the input resistance will approximately equal R1//R2//(hfe x (RE//RL)) or 100k//100k//(200 x (1k//1k)) giving 33.3k. (The // symbol means 'in parallel with'). Increasing R1 and R2 to 470k will increase this value to over 70k, giving a relatively high input resistance.

Voltage gain

The next thing to describe is the operation of the circuit. In principle, the voltage at the emitter terminal will always be 0.6V lower (for NPN) than the voltage at the base. If the input signal increases the base voltage by +1V, the emitter voltage will also increase by 1V. Similarly, if the base voltage falls by 1V, so will the emitter voltage. In other words, the emitter voltage *follows* the base voltage and the output voltage is therefore virtually identical to the input voltage.

This means that not only will the two signals be in phase, but that the gain of the circuit (Vout/Vin) will approximately equal one. Because the emitter voltage follows the base voltage, the CC amplifier is often called an *emitter follower*. The waveforms for the CC amplifier are shown in Fig.2.

Output resistance

How the output resistance of the circuit is determined is a bit more difficult to describe, so we'll start by saying it's very low. When calculating input resistance, any resistance *after* (or to the right of) the base terminal needs to be multiplied by the current gain of the transistor. As described in Part 11, this includes RE, the load resistor RL and the transistor's internal emitter resistance known as 'little re'.

This latter resistance can generally be ignored when calculating input resistance for the CC amplifier, but it generally needs to be considered when determining the output resistance.

The output resistance is effectively that resistance seen looking into the emitter terminal of the transistor, so this

Fig.2:

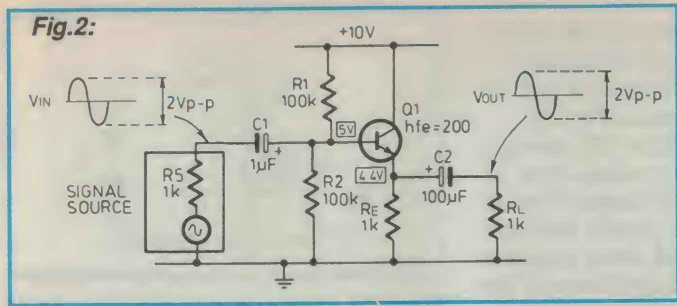


Fig.3:

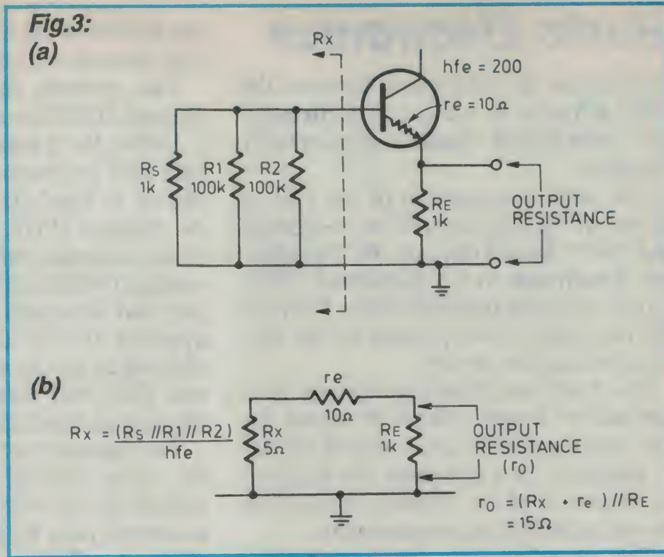


Fig.2: A practical CC amplifier requires that the emitter voltage equals around half the supply voltage.

Fig.3: The diagram in (a) shows the equivalent circuit for determining the output resistance of a CC amplifier. The total resistance of the parallel resistors at the base is divided by the current gain of the transistor depicted as Rx in (b). For the values shown, the output resistance is around 15 ohms.

time any resistance on the base side of the circuit needs to be *divided* by the current gain of the transistor. This will include the bias resistors (R1 and R2), and the resistance of the signal source. The diagram of Fig.3(a), shows the *equivalent* circuit, and because R1, R2 and Rs are all effectively in parallel, dividing their combined value by the current gain will result in a very low value.

If we call this resistance value Rx, then the output resistance of the circuit is approximately equal to Rx plus re. As well, the emitter resistor RE is also connected in parallel with (Rx + re), so the output resistance becomes even lower as shown in Fig.3(b). An important point is that the resistance of the signal source is a major factor in the value of the output resistance. Seems odd perhaps, but there it is.

Using the values shown in Fig.3(a), where the current gain of the transistor is 200, the output resistance of the circuit will be approximately (Rs/200) plus re or (1k/200) + 10, which equals 15 ohms. In fact the output resistance will be even less, as we haven't included R1, R2 and RE in the calculation.

Using the CC amplifier

Although it only has a gain of one, the fact that its input resistance is high and its output resistance low makes the CC amplifier particularly useful as a *buffer* stage. This is shown in Fig.4, where a CC amplifier is connected to a CE stage which in turn connects to another CC amplifier. The combined effect is an amplifier of three stages, with an input resistance determined by stage 1, a voltage gain determined by the CE amplifier of stage 2 and an output resistance established by stage 3.

The values shown in Fig.4 are typical for an amplifier of this type, and the waveforms show the phase relationships of the signals at each point in the circuit. In its simplest form, the circuit for Fig.4 would have each stage connected with a coupling capacitor, and each stage would have the usual biasing resistors, emitter resistor and, for the CE amplifier, a collector resistor. In other words, three conventional circuits joined with coupling capacitors.

To reduce the number of components, each stage can be *directly* coupled, in which the DC conditions of the first stage set the DC conditions for the rest of the circuit. Commercial circuits will often use ingenious methods to achieve a minimal number of components, while retaining the basic configuration of Fig.4. We won't attempt to describe such a circuit, as the possibilities are endless. But at least you can now see why an amplifier often has so many transistors.

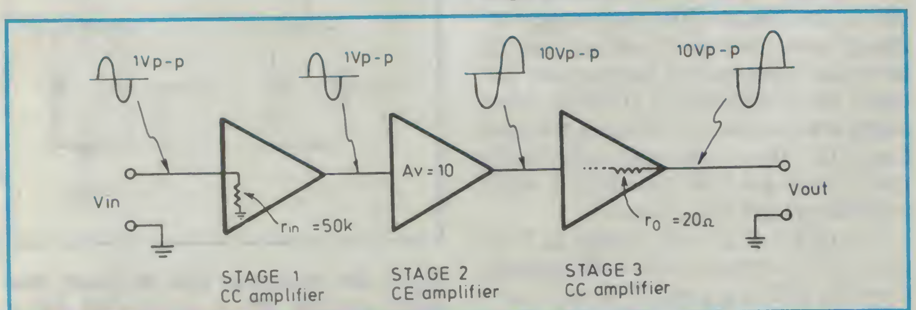


Fig.4: A three stage amplifier consisting of a CD amplifier before and after a CE amplifier. In this diagram, the input resistance is 50k and the output resistance is 20 ohms. The CE amplifier gives the whole circuit a gain of 10.

The FET

The FET has an interesting history, and is reputed to have its origins as a theoretical model as far back as 1930 or so. During the 1960's when valves were all the rage, it was possible to purchase 'solid state' valves, which consisted of a FET mounted on a valve base, probably with some extra components as well. If memory serves me correctly the idea never caught on, but it shows that the FET operates in much the same way as a valve.

The main difference between a conventional transistor and a FET is that the former is *current* operated and the latter *voltage* operated. In a transistor the base current controls the collector current. With the FET, the input *voltage* controls the output current, making it a totally different device to the transistor.

Like the transistor, there are two possible polarities for FETs — the N-channel type and the P-channel type. The N type is broadly comparable with the NPN transistor and the P type comparable with the PNP transistor. There are also two basic types of FET construction; the junction FET (JFET) and the metal oxide silicon FET (MOSFET). The MOSFET can have two modes of operation: enhancement and depletion mode, so there are six basic FET symbols to cover all the varieties.

There are also FETs with two gates, (dual gate FETs) so the list goes on.

Basic Electronics

We'll show the differences between the various types as we go as fortunately their principle of operation is essentially the same.

The basic construction of the FET is shown in Fig.5(a) for both the N-channel and the P-channel devices. We'll confine our description to the N-channel JFET, as the only practical difference between the two types is the polarity of the voltages around the device.

The basic construction consists of a *channel* of doped silicon, N doped for the N-channel FET and P doped for the P- channel. Two terminals are attached to either end of the channel, denoted as the *drain* and the *source* terminals.

The so-called *gate* terminal is connected to a second piece of doped silicon which has the opposite polarity to the channel. The gate section surrounds the channel and the effect is essentially a PN junction formed by the two pieces of doped silicon. This construction is similar for all types of FETs, except that the MOSFET has a layer of oxide insulation between the gate and the channel.

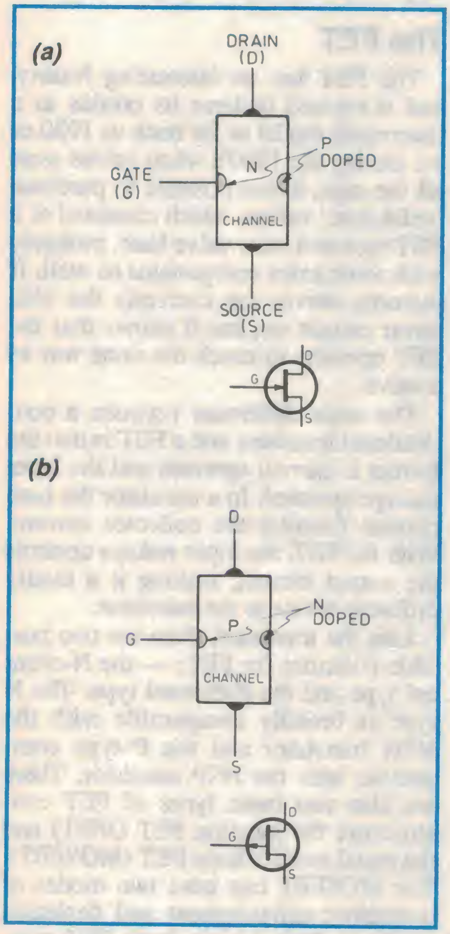


Fig.5: The diagram of (a) shows the basic construction of a FET, for both the N and P types. The symbols for the JFET are shown in (b).

The symbols for N-channel and P-channel JFETs are shown in Fig.5(b).

Unlike the transistor, the PN junction of a FET is operated in *reverse* bias, as shown in Fig.6. In this diagram for an N- channel JFET, the source terminal is the common terminal and a negative voltage (VGS) is connected between the gate and the source. A positive voltage is applied to the drain terminal and depending on the value of VGS, a current (ID) will flow from the drain to the source terminal.

The operation is very simple, in that the value of VGS controls the drain current ID. If VGS is zero, the current is limited only by the properties of the channel and the current that flows is known as IDSS. The value of IDSS is specified for each different type of FET, and is virtually independent of the voltage between the drain and source terminals.

The other important specification for a FET is the value of VGS that causes ID to fall to zero. This voltage, called VGS(OFF) is generally in the order of 2 to 6 volts, and for a JFET or a depletion mode MOSFET, must have a polarity that reverse biases the gate-source junction.

The gate controls the drain current with a 'voltage field', as depicted in Fig.7. In principle, as the reverse bias between the gate and source terminals is increased, the field *squeezes* the available space for the current to flow through. When the field is large enough it will completely restrict current flow. Hence the name 'field effect' transistor.

The relationship between the gate-source voltage and the drain current is non-linear, which complicates the analysis of a FET amplifier. This relationship is a measure of the gain of the FET and is given various names, included *forward admittance* (Yfs), *forward transconductance* (Gfs) or *mutual conductance* (gm). The measurement unit is the Siemen (for conductance) although some data books still use the old term *mho* (ohm spelled backwards). Because the relationship is ID/VGS, other manufacturers use variations of the term amp/volt. (Yes — take your pick!) We'll use the term gm (for those used to valve technology) and the unit mA/V.

To explain, if a 1 volt change in VGS gives a 3mA change in the drain current, then that FET has a gm of 3mA/V (or 3 millisiemens, or 3000uA/V or 3000umhos, etc). This FET will have a higher gm (and therefore a higher gain) than a FET where a 1V change gives a 2mA change in ID. Notice how we talk about a *change*, rather than static values.

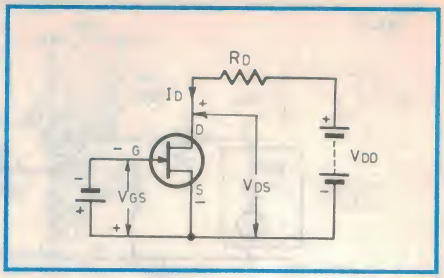


Fig.6: As shown in this diagram, an N channel JFET has its gate negative compared to the source (VGS), while the drain terminal is positive. The value of VGS will determine the value of the drain current ID.

Another important characteristic of a FET is its maximum operating voltage. This is variously labelled as VDS max, or BVGSS, or BVDS and so on, which for most small signal FETs is around 20 to 40V. Power FETs can handle several hundred volts, so don't think the FET is always a low power device.

Biasing the FET

At first it may seem that a reverse bias between the gate-source terminals will require a separate power supply to that supplying the drain-source voltage. While this is one way of achieving the required biasing voltage, there is another, much simpler way.

The circuit of Fig.8 shows a common source JFET amplifier, which as you can see has only three resistors plus the usual coupling capacitors. It works like this: The gate resistor RG holds the gate terminal at zero volts (for DC) and because it is the only path to ground for the input signal, it becomes the input resistance of the amplifier. When power is applied, current will flow from the drain to the source terminal, causing a voltage drop across RD and another across RS.

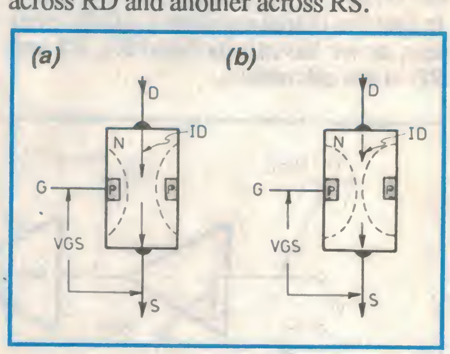


Fig.7: As shown in this diagram, the drain current ID is controlled by a voltage field set up in the channel by the voltage VGS. In (a), the field provides less restriction to the drain current than the field in (b).

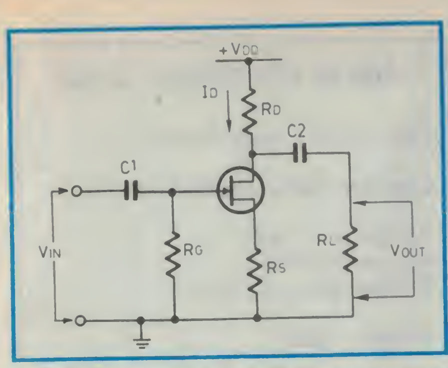


Fig.8: The circuit of a common source N-channel JFET amplifier is shown in this diagram. Resistor RG holds the gate at ground potential, RS develops a positive voltage at the source terminal and the output voltage is developed across RD.

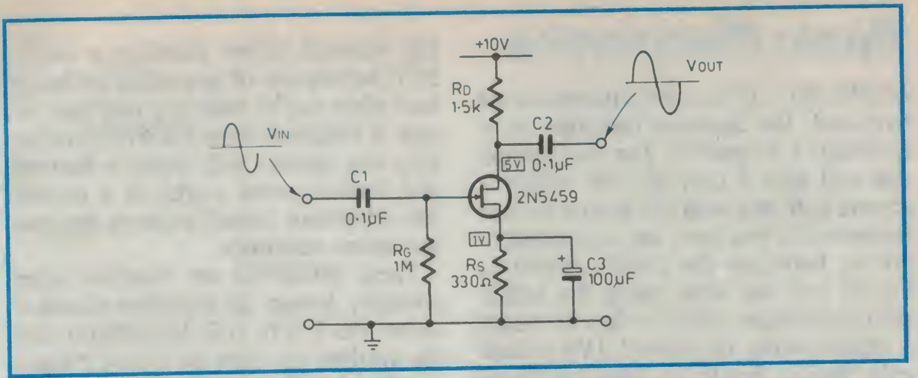


Fig.10: This circuit shows the JFET amplifier described in the text. The gain will be around 4 if the bypass capacitor C3 is connected, and the DC voltages should be within 20% of those shown.

By choosing the correct value for RD, the voltage drop across it will give a value of half the supply voltage at the drain terminal. So if we assume a supply voltage of 10V and a drain current of 3mA, RD needs to be 1.67k to cause a 5V drop, giving 5V at the drain terminal. The nearest preferred value is 1.5k, which will be close enough. OK, but how does the circuit work to give the required drain current?

The answer is by choosing an appropriate value for RS. When current is flowing through the FET, a voltage drop will be developed across RS, with the source terminal positive compared to the common line. Put another way, the common 'earth' line will be negative with respect to the source, and because the gate is connected via RG to the common line, the gate will be negative with respect to the source terminal.

The value of RS can be determined mathematically or graphically by using a curve like that of Fig.9. In this curve, IDSS is 6mA and VGSOFF is -4V, which are typical values for a small signal FET. The curve between these points is a plot of the relationship between ID and VGS, and the shape of this curve is the same for all FETs.

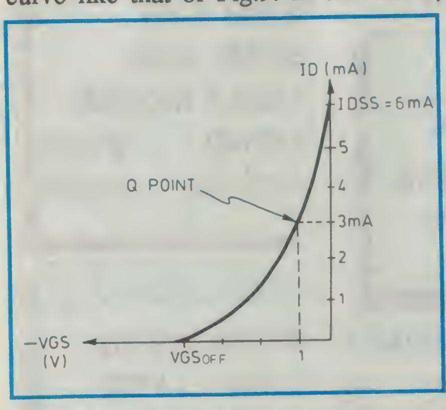


Fig.9: This curve, called a transfer curve, shows the relationship between the gate-source voltage and the drain current for a typical JFET. The Q point is chosen to give a drain current of around half IDSS, requiring a gate-source voltage of 1V in this case.

By choosing a quiescent drain current of approximately *half* IDSS (i.e., 3mA in Fig.9), the gate-source voltage to cause this can be determined from the curve, which in this case is around -1V. By Ohm's law, RS equals VGS/ID, or 1V/3mA giving 330 ohms. This leaves the value of RG and the design is complete.

As it turns out, RG is the simplest of all to determine. We said before that the input resistance of the amplifier is determined by RG, so simply pick the value you want, up to a maximum of 1M for a JFET, or 10M for a MOSFET. You might like to now hook up this circuit using a 2N5459 JFET, (or an equivalent like the MPF105 or a 2N5458). You will find that the voltages will be around those we've calculated, although FETs of the same type have wide differences in their values of VGSOFF and IDSS — meaning the actual values of VD and VS will vary by 20% or more.

The AC conditions

The operation of a FET amplifier relies on the input signal changing the quiescent value of VGS, much like the input signal to a transistor amplifier changes the value of the base current. When the input voltage causes VGS to become more positive, (or less negative) the drain current will increase. This will result in the drain voltage falling, as there is now a greater voltage drop across the drain resistor RD. If VGS is made more negative by the input voltage, the drain current will reduce and the drain voltage increase.

Therefore, the output voltage for a CS (common source) FET amplifier will be 180° out of phase with the input voltage, as for the CE amplifier. But what about the voltage gain? There are two possible conditions to consider: whether RS is bypassed with a capacitor or not. If there is no bypass capacitor the gain will be quite low, although even when it is bypassed the gain will still be relatively low. The fact is, a FET amplifier usually has a low voltage gain, and its main advantage is its high input resistance.

To calculate the gain of the amplifier, you need to know the gm of the FET, which can be found in manufacturer's data. As a rough approximation, you can also calculate the gm of the FET where gm equals VGS/ID, giving 3mA/V for the example design.

If the source resistor RS is bypassed, the gain of the amplifier is calculated by multiplying RD by gm. That is, Av = gmRD, which for our circuit works out to be 4.5. Not much of a gain compared to a transistor amplifier! If a load (RL) is connected to the amplifier, the gain will be even less, as RL must be included in the gain equation — in which case RL is in parallel with RD giving Av =

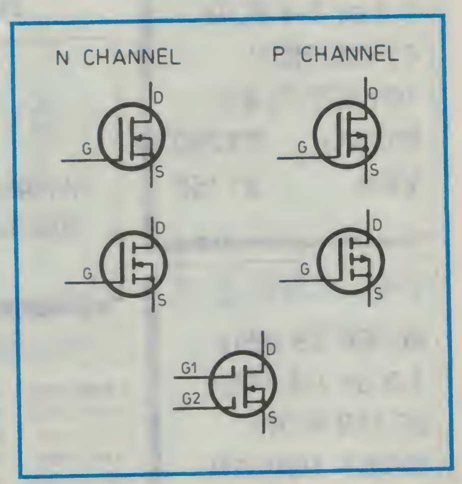


Fig.11: MOSFET symbols where (a) shows the DE-MOSFET, (B) the enhancement mode MOSFET and (c) the dual gate N channel MOSFET.

gm(RD//RL). If the source resistor is not bypassed, the equation becomes Av = (gmRD)/(1 + gmRS). For our circuit, this will give a gain of 2.25, which is around half that with the source resistor bypassed. If you have the equipment to do so, hook up the circuit shown in Fig.10 and see how close the actual gain figures are. The circuit will accept a signal swing of around 1Vp-p, and gain figures should be similar to those calculated.

Finally, the output resistance for a CS JFET amplifier equals the value of the load resistor RL. Therefore, like the CE transistor amplifier, the output resistance of a CS amplifier is relatively high.

The MOSFET

As we've already said, there are several types of MOSFETs, but a common characteristic is that a very thin layer of oxide insulation is placed between the gate junction and the channel. This allows the gate-source junction to be forward biased and also reduces the gate-source leakage current when it is reverse biased. As a result, very high input resistance values are possible — so high that static voltages can easily destroy a MOSFET. This requires earthing yourself before handling a MOSFET, and the use of an earthed soldering iron when you're soldering one into circuit. A feature of some MOSFETs is that they can operate with either a forward bias (enhancement mode) or a reverse bias (depletion mode) between the gate and source terminals.

These MOSFETs are therefore more correctly known as depletion-enhancement MOSFETs (DE-MOSFETs) and the symbols for both the N and P types are shown in Fig.11, in which the gate is depicted as being separated from the channel to indicate the oxide resistance layer.

A JFET operates in depletion mode (or reverse bias mode) only and a depletion-enhancement MOSFET can be used in place of a JFET, although its full operating capabilities won't always be realised. Another type of MOSFET requires a forward bias to operate at all, and these are known as *enhancement* mode MOSFETs, with a symbol shown in Fig.11(b). This symbol has a broken line for the channel, indicating that a forward bias is required to complete the channel. The symbol of a *dual gate* N-channel MOSFET is shown in Fig.11(c). With this type of MOSFET, one gate can be used to establish the DC conditions while the input signal can be applied to the other. Dual gate MOSFETs are often used in radios and communications equipment.

In the next part, we describe the basic power amplifier and present a design you can build.

Table of Equations Used

Note: // means 'in parallel with'

Common collector amplifier, refer Fig. 2.

Voltage gain = unity
Input resistance =
$R1//R2//[hfe(re + RE//RL)]$

where $re = \frac{30mV}{Ic}$

Output resistance =
$\left(\frac{Rs//R1//R2}{hfe}\right)//[re + (RE//RL)]$

Common source FET amplifier,
refer Fig.8.
Voltage gain
$= gm\,(RD//RL)$ source resistor bypassed
$= \frac{gm(RD//RL)}{1 + gmRs}$ source resistor unbypassed

Input resistance = RG
output resistance = RD

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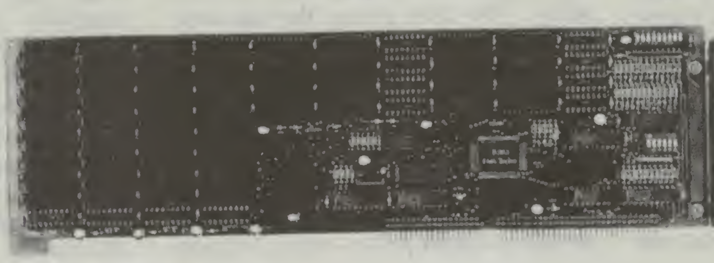
EMS turbo



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READER INFO NO. 21

Construction Project:

HALL EFFECT SPEED SENSOR

This project has numerous applications, but its main purpose is to offer an alternative type of sensor for projects such as our Digital Speedo, Intelligent Blinkers and Trip Meter. It's easy to build, easy to install and a kit costs a mere $12.

by JEFF MONEGAL

Although automotive projects are one application, producing an electronic signal proportional to the speed of rotation of a shaft is often required in other applications. A common method is to attach magnets to the shaft and to place a coil near the magnets, so their magnetic field can produce an output from the coil.

However this requires making a coil, an often tedious procedure unless you have a coil winder, and the resultant device is usually fairly heavy and bulky. Then it has to be mounted securely, so the pole face is relatively close to the magnets. While many commercial instruments and automotive add-ons use such a device as the sensor, there is a better way.

In fact, feedback from constructors of our popular automotive series has prompted the development of this Hall effect sensor. It seems the coil and magnet sensor caused a few problems, as a result of the mounting distance being too far from the magnets, the difficulty in obtaining uniform layers during the winding of the coil and terminating the fine winding wire to thicker hookup wire.

We have built several prototypes, with extensive testing on several cars over several thousand kilometres. One of the prototype sensors was mounted under a rally car, with the driver reporting no problems during a recent rally in Canberra. Unfortunately, the car attempted to take a short cut down an embankment and while we believe the sensor stills works, we are currently unable to find it!

The sensor unit is smaller than the usual sensing coil (and much lighter) and is therefore easier to fit under the car. The complete unit consists of two sections: the sensor section and a signal processing section that can be fitted inside the case of a project using the device.

Use our all new Hall effect speed sensor instead of the usual coil and magnet sensor to sense the rotational speed of a shaft. It can be used in a range of applications , particularly with our recently published automotive projects.

To make a rugged unit suitable for mounting under a car, we constructed an enclosure from double-sided PCB sections to fit around the PCB holding the components associated with the sensor. We then potted the assembly with epoxy glue, giving a unit capable of withstanding the harsh environment found under the average vehicle.

How it works

The Hall effect IC, in conjunction with magnets attached to the shaft, produces output pulses with a frequency determined by the speed of rotation of the shaft. The rest of the circuit amplifies and conditions the signal so it can be applied to the sensor input of the various projects referred to previously (or other applications).

The Hall effect element can be regarded as a flipflop, in which a north pole sets the output to a high and a south pole resets it to a low. This means the magnets need to be mounted on the shaft with alternate north and south poles.

If two magnets are attached to the shaft, one cycle of a square wave is produced per revolution, whereas the coil sensor gives two. To make this sensor compatible with circuits using a coil sensor, it is necessary to convert

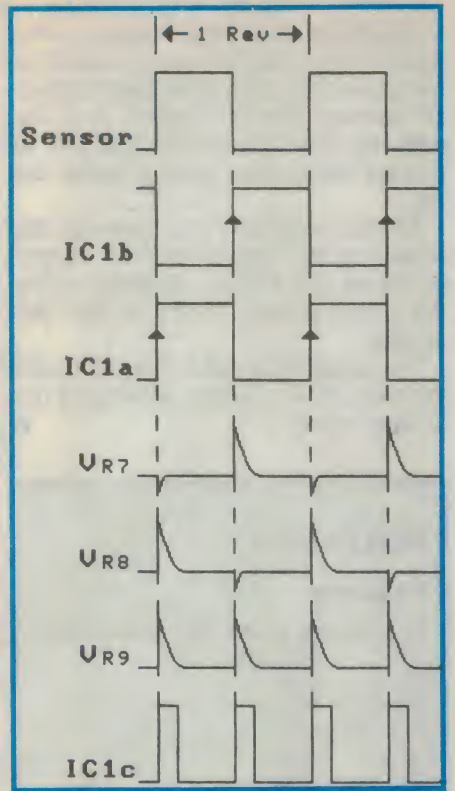


Fig.1: These waveforms show how the circuit develops two output pulses per revolution. The differentiating networks produce positive spikes from the outputs of the comparators IC1a and IC1b. The spikes are ORed by D3 and D4, then applied to IC1c which gives the final output.

the single pulse into two pulses. This is achieved by developing pulses from the *changes*, rather than using the basic pulse directly.

The output from the Hall effect sensor is applied to the two comparators of IC1a and b, via the coupling resistors R3 and R4. When this signal swings low, the output of IC1b will go to its maximum positive value and the output of IC1a will fall to virtually zero. The opposite occurs for a positive input. In effect, the output of IC1a equals the input signal, and the output of IC1b is the inverse of the input as shown in Fig.1.

The outputs of both comparators are coupled to differentiating networks (C2 and R7 for IC1b, C3 and R8 for IC1a). Diodes D1 and D2 prevent the voltage across R7 and R8 from swinging negative.

When the output of either comparator swings high, a positive pulse will occur across R9 via the isolating diodes D3 and D4, which couple R9 to the two differentiating networks.

The diodes form an OR gate and as a result, there are now two positive-going pulses developed across R9 for one cycle from the sensor.

The voltage across R9 is applied to IC1c, which is connected as a high gain non-inverting amplifier. The output of IC1c is the final output, that is applied to the circuit receiving the pulses.

R1 and R2 provide the necessary bias for the Hall effect device and IC2 is a low power 8V regulator that ensures a stable supply to the circuit. Filtering of the supply is provided by capacitors C1, C4 and C5.

The IC used in the circuit is an RCA device, type CA3401, which is similar to the National LM3900 op amp. Both devices are current differencing (or Norton) op amps; they even have the same pin connections, but tests have shown that the LM3900 type is not as reliable in this application.

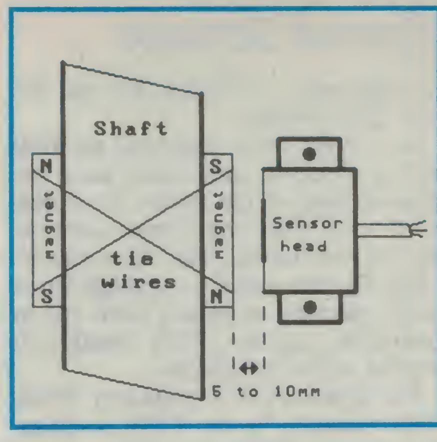


Fig.2: The magnets for the sensor need to be mounted with their polarity reversed, as shown here. Attach the magnets to the shaft with double-sided adhesive tape, then bind them with wire.

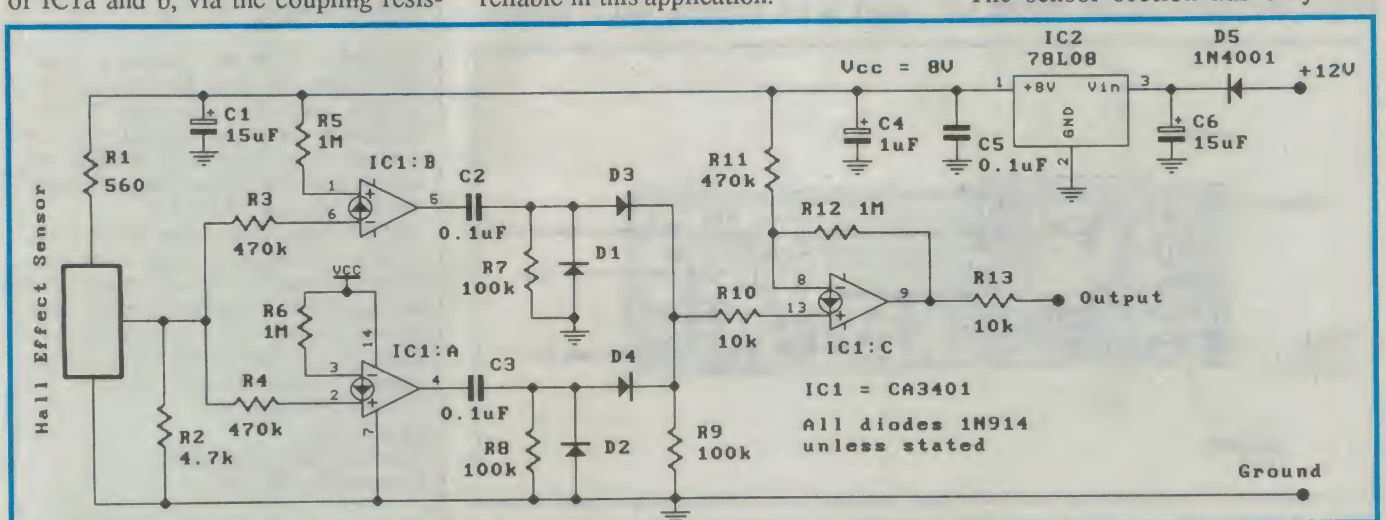
The biasing arrangements for a Norton op amp are different to conventional op amps, and resistors R5, R6 and R11 are used to develop the necessary bias for the three amplifiers.

Construction

It is recommended that a kit be purchased for this project as it contains all the correct components. For only $12.00 you get the miniature 1/8 watt resistors, the Hall effect element, a strip of blank double-sided PCB material and the correct magnets — as well as the PCB and all remaining components.

The PCB needs to be cut as shown on the layout diagram, to separate the sensor section and the signal processing section. Use a saw with a fine blade, or even a pair of tin snips.

The sensor section has only four



The Hall effect device produces an output that reverses polarity when a north and then a south magnetic pole passes across the face of the element. The rest of the circuit develops two positive-going output pulses per input cycle as shown in Fig.1.

components — C1, R1, R2 and the Hall effect device.

Be careful when soldering the Hall effect element, and make sure the ceramic face of the device faces outwards. There are three wires connecting the two boards, and these can be relatively thin wires — perhaps fitted inside sleeving to protect them and to keep them together. Their length will depend on the installation.

The signal PCB is purposely small, made possible by the 1/8W resistors. This way the PCB can easily be tucked inside the project it is connected to.

However, you'll need to be careful when soldering, as some of the pads and tracks are quite small.

Fit and solder all the resistors, capacitors and diodes, taking care with the orientation of the latter devices. Then fit the regulator IC and IC1. An IC socket is recommended in case of faults, as desoldering the IC could damage the PCB.

Check your soldering, in case of accidental bridges, then connect the wires for the 12V supply and the signal output. Also, temporarily connect the two boards together so the unit can be tested.

Apply 12V DC to the signal board and connect either a 'scope or an analog voltmeter to the output. A digital voltmeter will not be effective, as it cannot respond quickly enough to show an output.

Then pass a magnet across the face of the Hall effect element. You should see short positive pulses each time the magnet is moved across the face of the element, although you'll need to reverse the polarity of the magnet for each pass. If all is well, it remains to build the PCB box around the sensor section as shown in the photograph.

Cut the double-sided PCB material to size, then solder it to form a three-sided box that can wrap around the board holding the components.

Drill an exit hole in the rear of the enclosure for the three connecting wires, then solder a piece of PCB to form the support bracket that attaches the assembly to the vehicle.

Cover the track side of the component board with silicone glue, then glue the enclosure to the board. To protect the electronics, fill the cavity with silicone glue (or an epoxy glue).

Be sure the unit is functional before doing this, as once the glue sets, that's it! Also, make sure you've passed the wires through the exit hole first.

Installation

The magnets supplied with the kit are bar magnets similar to those used with reed switches.

As depicted in Fig.2, they need to have their magnetic poles arranged so that one magnet has the opposite polarity to the other.

Note that four magnets are needed if the unit is fitted to a vehicle with front wheel drive, as the drive shaft turns more slowly.

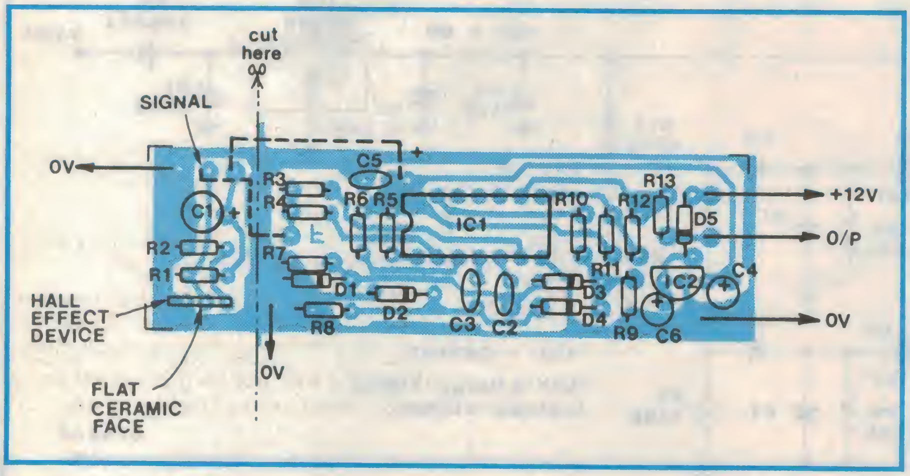
The sensor should be mounted so it is within 5 to 10mm of the magnets, and positioned so the sensing element is central to the magnets.

The two magnets are held to the shaft using good quality double-sided adhesive tape, and then strapped to the shaft with strong wire.

Place the magnets directly opposite each other so the balance of the drive shaft is not affected, and if possible mount them close to a bearing point. Run the wires so they are protected as far as possible, then pass them through an opening into the cabin. Seal the opening with a suitable sealant to prevent water from getting inside the car.

All that remains is to connect the sensor to the project and to supply power to the circuit, probably using the same power leads as for the project.

The signal PCB can be placed inside the case of the project, positioned out of harm's way. ■



The PCB needs to be cut as shown before commencing construction. Three wires then connect the two PCB sections as indicated. All resistors are 1/8W to keep the size of the PCB as small as possible.

PARTS LIST

Resistors

All 1/8W, 5% unless otherwise stated:

R1	560 ohm
R2	4.7k
R3,4,11	470k
R5,6,12	1M
R7,8,9	100k
R10,13	10k

Capacitors

C1,6	15uF, 16V low profile electrolytic
C2,3,5	0.1uF monolithic
C4	1uF, 16V electrolytic

Semiconductors

D1-4	1N914 signal diode
D5	1N4001 1A diode
IC1	CA3401 quad Norton op amp
IC2	78L08, TO-92 8V regulator
	Hall effect sensor

Miscellaneous

PCB, 75mm x 23mm; strip of double-sided PCB; two or four bar magnets, hook-up wire, solder etc.

A kit of parts for this project is available from CTOAN Electronics for $12.00, which includes the PCB and all components. Add $1.00 for post and packing. Fully built, tested and epoxy potted units can be purchased for $19.00, plus $1.00 P&P.
CTOAN Electronics also offers a full backup and repair service for the kit. Cost for repair is $9 which includes replacement of any component and return postage. Sensors that have been potted cannot be accepted for repair. To order, write or phone:
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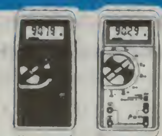

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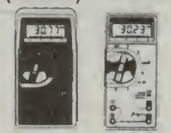

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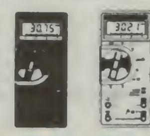

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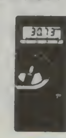

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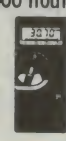

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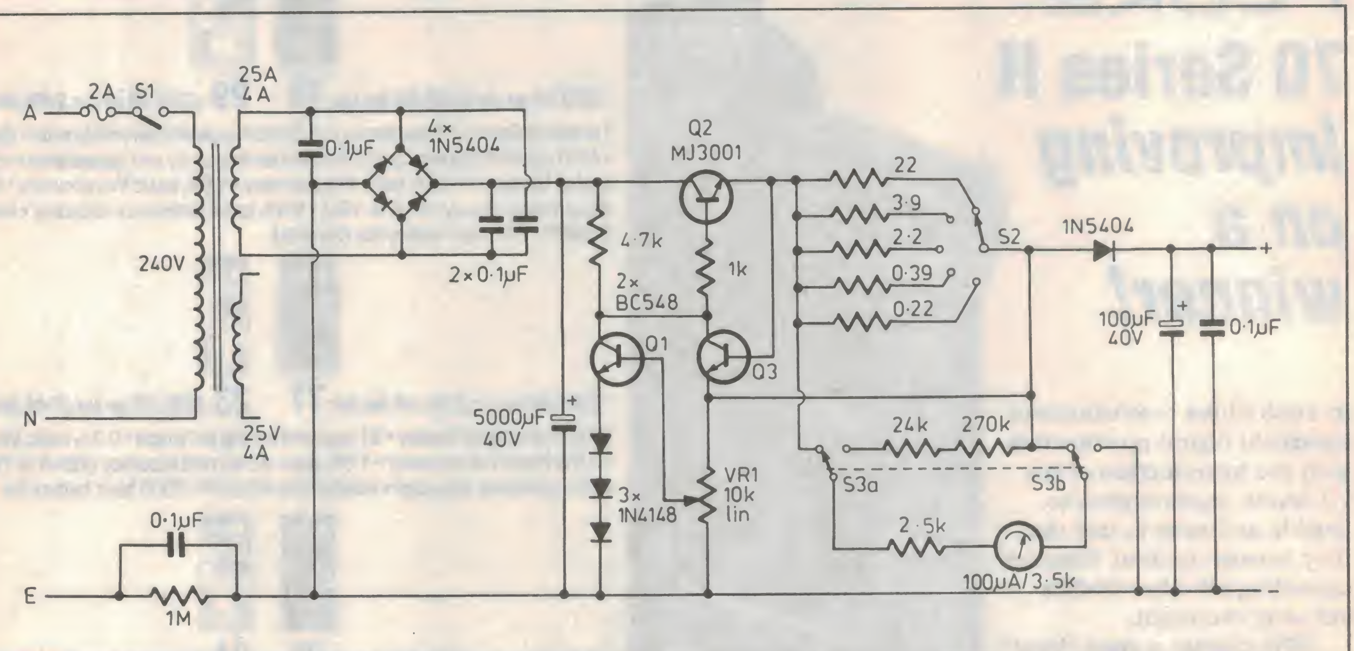
READER INFO NO. 22

Circuit & Design Ideas

Interesting circuit ideas from readers and technical literature. While this material has been checked as far as possible for feasibility, the circuits have not been built and tested by us. We therefore cannot accept responsibility, enter into correspondence or provide further information.



30V, 3A power supply

This power supply has been in use for some years, with the circuit being duplicated to provide a double power supply. When connected in series, the maximum output is 30V at 3A for each supply (-30V - 0 - +30V), or 30V at 6A when connected in parallel.

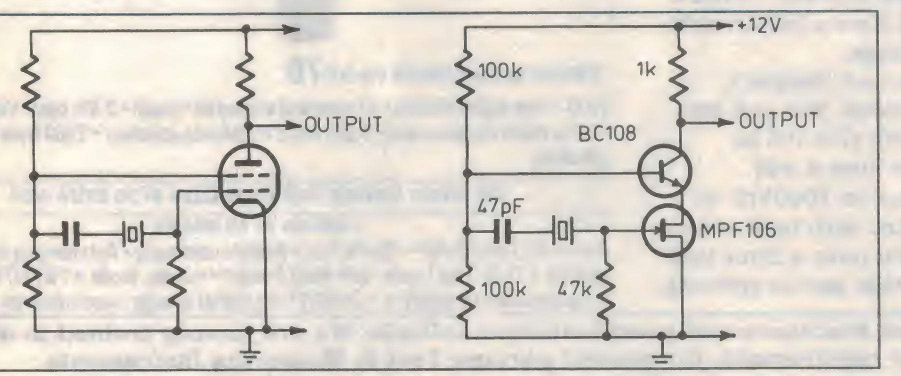
The potentiometer VR1 sets the output voltage between 2V and 30V, while rotary switch S2 sets the maximum current: 30mA, 150mA, 300mA, 1.5A and 3A.

The switch contacts for S2 must be rated at 3A and the power transistor Q2 must be mounted on a largish heat sink.

If the output is short-circuited or the maximum current exceeded, then the supply shuts down. Transistor Q3 controls this overload function.

The five resistors connected across its base-emitter by switch S2 control the switching of the transistor. They also act as current shunts for the meter (Atronic model Q0506). The calculated values for these five resistors were actually 20, 4, 2 0.4 and 0.2 ohms, but preferred values were used without noticeable inaccuracy. If another meter is used which differs from this 100uA, 3.5k model, then the values of the 2.5k, 24k and 270k resistors may need adjustment. Switch S3 allows the one meter to read either current or voltage, while the diode in the output stage stops interaction between the supplies when they are connected in parallel.

Stewart Farrant,
Perth, WA $35



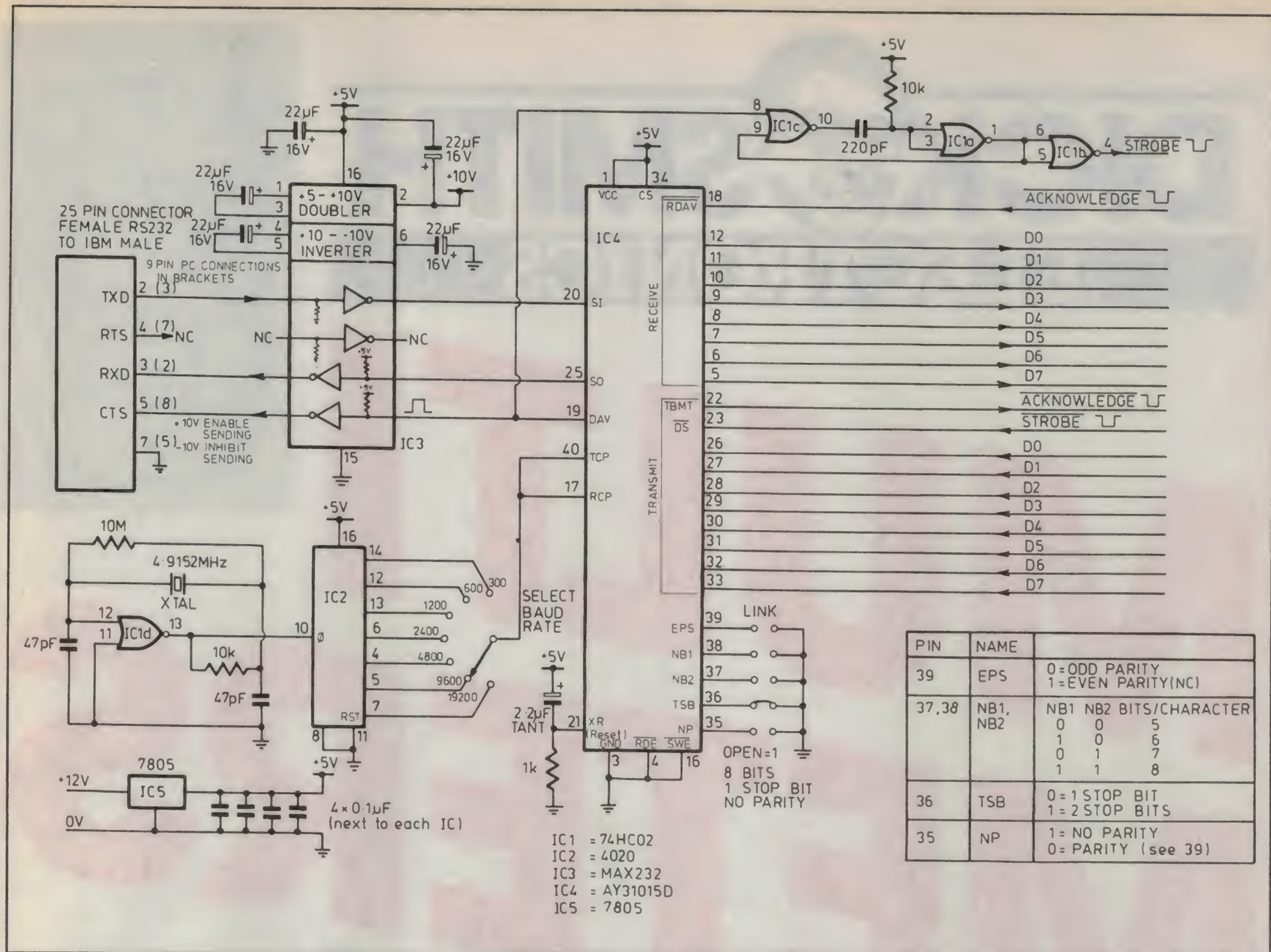
Transistor Pierce oscillator

A crystal oscillator circuit which was often used with tetrode and pentode valves was the modified Pierce oscillator. This is a form of electron-coupled oscillator: the feedback path being from screen grid to control grid, with the screen grid being used as the oscillator anode.

The output is taken from the anode, so there is no direct connection between the ouput and the oscillator circuit itself — this aids stability. This circuit shown on the left is not directly convertible to FET use, because the gates in the FET do not draw current as the screen grid of the valve did.

However, using a hybrid cascode circuit with a FET as the lower stage and a bipolar transistor as the upper stage, the circuit behaves like the original valve circuit.

R.H. Bennett,
Auckland, NZ $35



PIN	NAME	
39	EPS	0=ODD PARITY 1=EVEN PARITY(NC)
37,38	NB1, NB2	NB1 NB2 BITS/CHARACTER 0 0 5 1 0 6 0 1 7 1 1 8
36	TSB	0=1 STOP BIT 1=2 STOP BITS
35	NP	1=NO PARITY 0=PARITY (see 39)

RS232 parallel converter

This circuit converts RS232 signals to parallel signals, and vice versa. Most of the work is done by IC4, a universal asynchronous receiver/transmitter (UART).

Serial data enters the UART pin 20 after being conditioned by IC3, a MAX232. When a complete word has been read in, the data available line (pin 10) goes high.

The L-H transition triggers the monostable built around IC2, the 74HC02. The H level on pin 19 also pulls the CTS line on the RS232 port to -10V, so preventing any further bytes from being sent.

After this byte has been processed by the peripheral device (e.g., a parallel printer or EPROM programmer, etc.), the peripheral pulses pin 18 of the UART low, which resets the DAV flipflop. The CTS line goes to +10V and the computer is able to send another byte.The reverse procedure, parallel to serial conversion, is also done largely within the UART.

A strobe (negative pulse) on pin 23 (data strobe) enters the data bits into the data bits holding register. Pin 22, the transmit buffer empty pin, goes low until this byte has been sent, so preventing the peripheral from sending another byte.

IC1d is a 4.1952MHz clock which is divided down by IC2 — baud rates between 300 and 19200 can be selected.

The UART has been set up for eight bits, one stop bit and no parity, which seems to be a common standard for printer ports.

To test the circuit, the output strobe line and pin 18, RDAV (acknowledge) should be tied together.

The peripheral circuits which I have used with this converter, namely an EPROM programmer and a 64-port A/D/A converter, work on the protocol that the computer sends a byte, and then gets a byte back.

In these peripherals, the output strobe is connected to both pin 18 of the UART and via a 74HC123 delay to pin 23 also. The software consists of an OUT in BASIC, a delay and then an IN to read the returned byte.

IC2 must be able to run at 4.9MHz as this is the minimum specification for Fairchild or Philips ICs.

The speed for National chips is slight lower, although some chips may work. The symptom of a slow device is that the first stage divides by '3' instead of '2'.

James Moxham
Urrbrae, SA **$40**

DREAMED UP A GREAT IDEA?

If you have developed an interesting circuit or design idea, like those we publish in this column, why not send us in the details? We pay for those we publish — not a fortune, but surely enough to pay for the effort of drawing out your circuit, writing down some brief notes and posting the lot (together with your name and address please), to:
Jim Rowe, Electronics Australia, PO Box 199, Alexandria NSW 2015.

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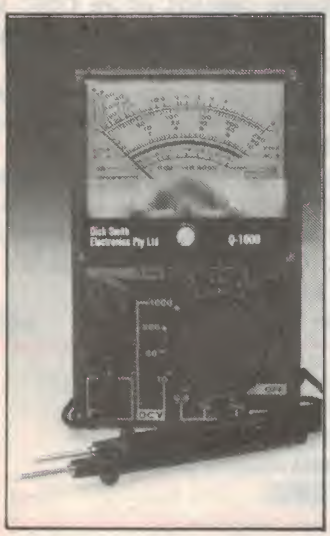

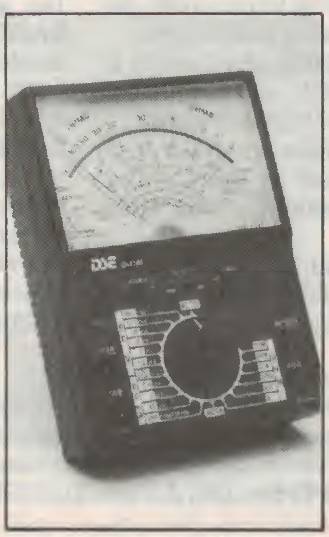

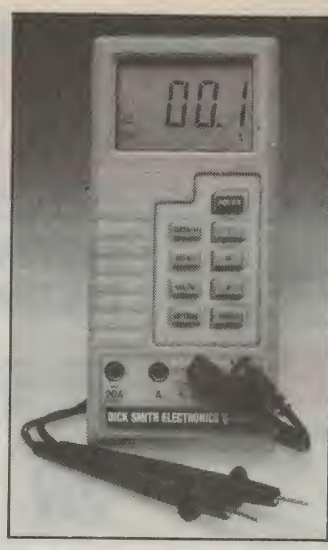

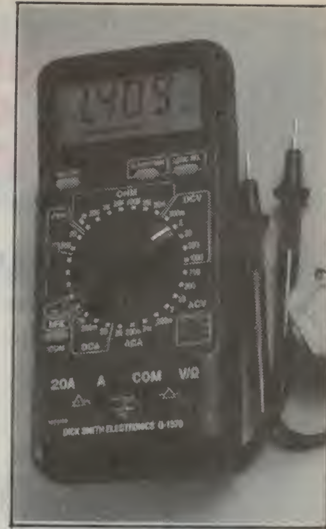

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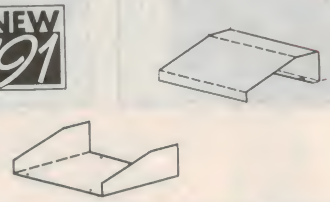

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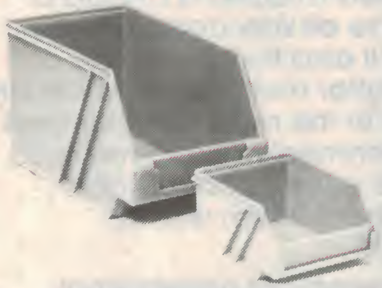

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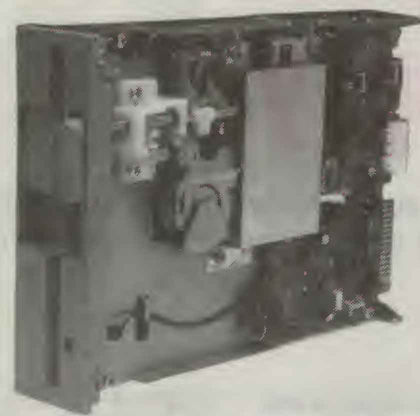

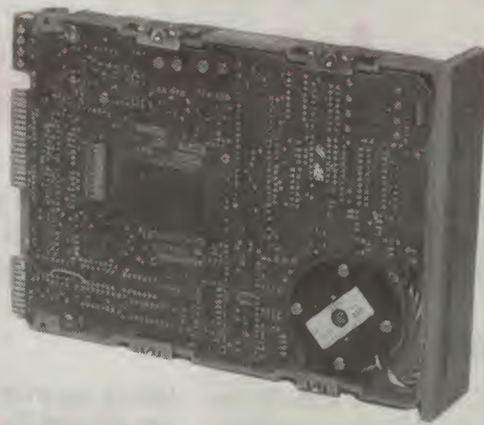

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Construction project:

Low cost 18V/1A benchtop supply

Need a mean, lean, recession-compatible 1A power supply for your workbench? If so, this project should be just the shot — it features variable output voltage from 2.5 to 18V, switchable current limiting, and both voltage and current metering.

by ROB EVANS

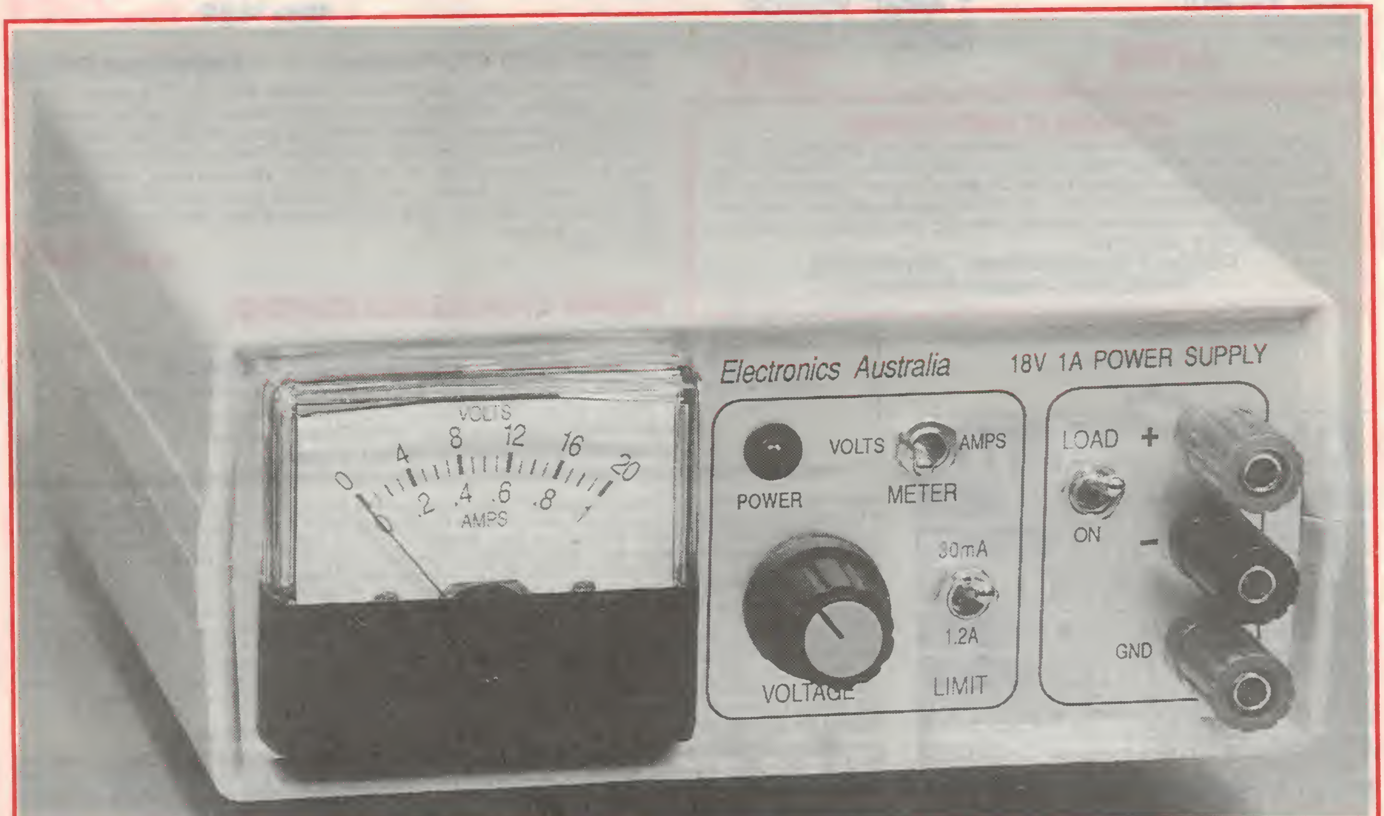
Most readers will have noticed the regular stream of DC power supplies described in *EA* over the years, and the high profile enjoyed by these kits in the electronics store's catalogs. Not surprisingly, the reason for their prominence is quite straightforward; a benchtop supply is the power source for just about everything that appears on a typical electronics workbench — in fact, you can do very little without one...

So here's yet another power supply, to satisfy the never-ending demand. In this case however, we've taken a careful look at just what a typical supply is used for, included the important features and trimmed off the fat — so to speak. The resulting design can be built for a much lower cost than most of the earlier designs, yet still offers excellent performance and a host of practical functions.

Design considerations

When it came to analysing the typical uses of a benchtop supply, we found that most loads (that is, circuits) require a source voltage in the range of 5 to 15 volts, and generally draw an operating current of less than one amp. The circuits which *do* consume more current tend to be automotive devices and radio transmitters, both of which are far more suited to a dedicated 13.8V high-current supply — such as those in the *EA* 'VK Powermate' series.

Once we had restricted our supply's design parameters to these practical limits, several cost advantages were immediately obvious. Namely, the size of the transformer, filter capacitors, circuit board, and (significantly) the case could all be reduced — these factors alone



slice about 30% off the cost. And as an added bonus, the lower circuit voltages result in a substantial decrease in component dissipation, and much higher thermal headroom — in other words, the supply won't get as hot, and is able to sustain an almost indefinite overload condition.

Further observation told us that a benchtop supply with *variable* current limiting is mostly used at the extremes of its current adjustment. That is, we tend adjust the control to the maximum current position (say 1A) when powering a device or circuit that is up and running, so that we won't be bothered by the supply mysteriously shutting down when a lower current limit is reached — even though the circuit is operating correctly.

On the other hand, it makes sense to use the minimum current setting when experimenting or developing a circuit, so that the supply will shut down if a fault or overload occurs — in practice, quite a likely event. This sensitive limiting action tends to protect the circuit components from excessive dissipation, and warn the user that something is amiss as the supply's voltage falls.

So while fully variable current limiting is a useful feature in a benchtop supply, all we *really* need is a low setting to protect the load, and a high setting for protecting the actual supply during an overload. On the strength of this information, our new circuit simply has a two-position switch to control the current limiting — a 1.2A setting for normal circumstances, and a 30mA position for experimenting.

SPECIFICATIONS

Output voltage: Adjustable from 2.5V - 18V
Output current: Up to 1.2A (see load curves)
Load regulation: Better than 0.15% at 1A output current
Line regulation: Better than 0.1% for 210-260V AC input
Output ripple: Less than 1mV at 1A output current
Current limit: Switchable between 30mA and 1.2A

You may have noticed already that the usual mains on/off switch is missing from the supply's front panel — this has been done for practical, cost and safety reasons. Firstly, a mains-rated switch won't easily fit into the front panel space, due to the small (read: inexpensive) box that we have chosen.

Secondly, the switch is an additional expense which can be avoided — simply turn the supply on and off at the wall socket. And finally, a substantial amount of extra mains wiring is needed to connect the switch, which raises the possibility of dangerous wiring mistakes and exposed terminals at lethal voltage levels — as it stands, the mains cord connects only and directly to the transformer.

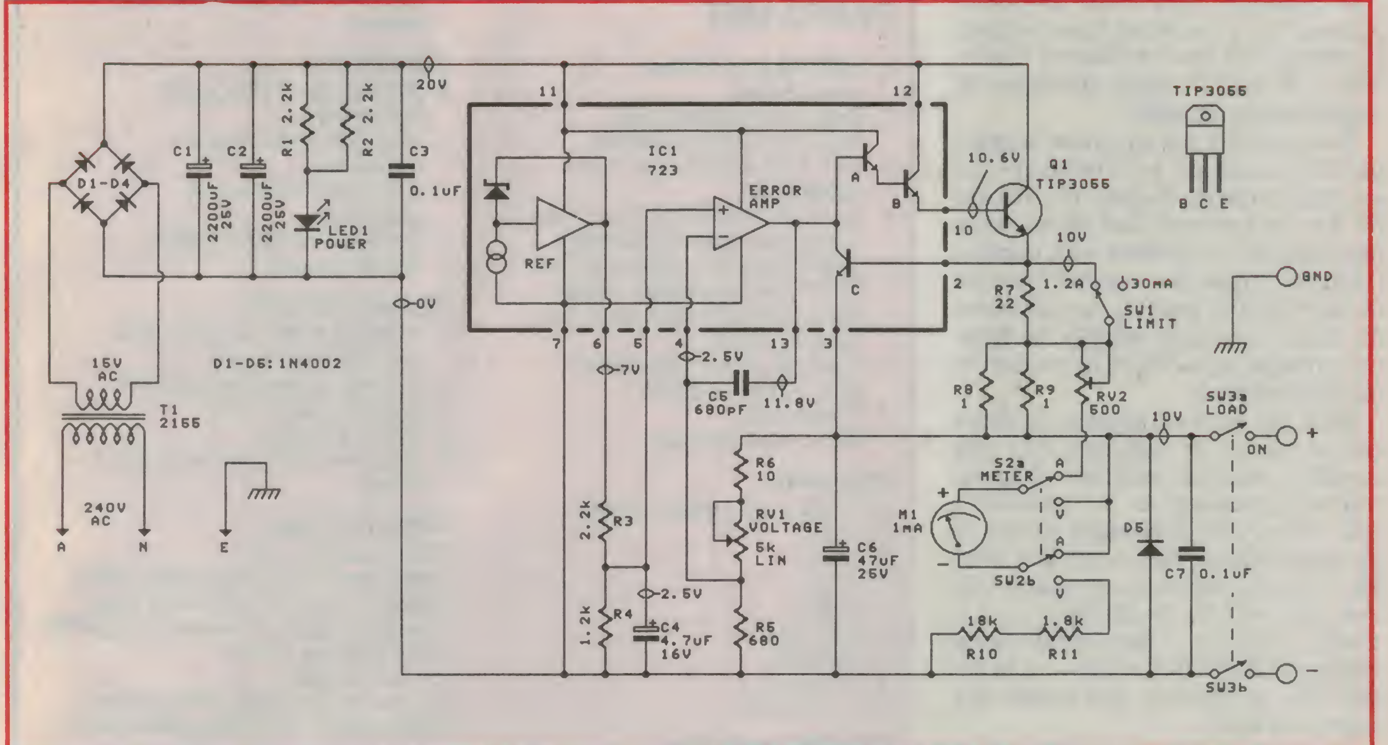
The features from past designs that we *have* retained were considered far too useful to drop. These include full voltage and current metering via a quality meter movement, output load switching, banana-style output terminals and of course, a high performance circuit.

So there we have it, a compact benchtop power supply with all of the essential features needed for a typical workshop. Even if you already have a similarly equipped supply, this unit can be added to your collection for a very modest cost — as the old adage says, you can never have too many power supplies.

Circuit description

As you can see from the associated schematic, the supply's circuit is based around a common 723-type regulator chip (IC1), which is represented by the components inside the box in the center of the diagram.

This chip offers all of the essential ingredients for a quite sophisticated power supply, such as a temperature compensated voltage reference, a high-gain error amplifier, and series-pass and cur-



The overall schematic diagram. Note that we've shown the internal functions of IC1, which forms the heart of the supply's circuit.

Benchtop Supply

rent sensing transistors. We've elected to show the IC's internals as part of the schematic, to make the circuit's operation as clear as possible.

All that's needed to complete the supply is an external series pass transistor (Q1) to increase the output current capability, a source of unregulated DC voltage (T1 and associated components), and the voltage scaling, metering and current limiting components (the remainder of the circuit).

Mains voltage is applied to the circuit via a standard 2155- type transformer (T1), which has a nominal secondary rating of 15V AC at 1A.

This winding feeds the full wave rectifier based on diodes D1 to D4 and filter capacitors C1 and C2, which produce an unregulated supply source of around 20V DC for the following circuitry. LED1 and its associated current limiting resistors (R1 and R2) provide power on/off indication.

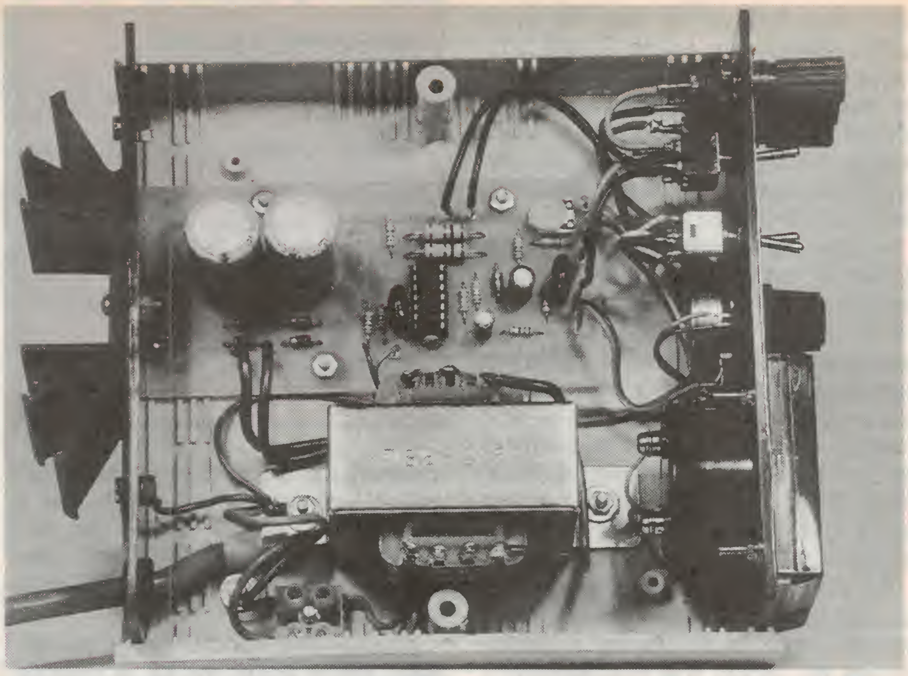
The op-amp, zener diode and current source shown towards the left of IC1's diagram act as an active voltage reference, supplying a stable voltage of around 7V at pin 6. This is then reduced to 2.5V by the voltage divider R3 and R4, filtered by C4, and applied to the non-inverting input of IC1's internal error amplifier at pin 5.

In practice, this error amplifier operates as a standard non-inverting amplifier, with emitter follower transistors A, B and Q1 simply increasing its output current capability.

If we consider that the power supply's positive terminal is effectively the amplifier's output (neglect R7, R8 and R9 for the moment), and the inverting input (pin 4) is provided with negative feedback from the output (via the divider R6, RV1 and R5), we can expect the circuit to simply amplify the reference voltage appearing at its non-inverting input on pin 5.

Since the level of negative feedback can be altered by adjusting RV1 (the supply's voltage control), the corresponding change in the amplifier's gain will vary the final output voltage. In the actual circuit, this means that when RV1 is at its maximum resistance (5k) the gain will be 1+(5k/680) or 8.4, which produces a theoretical output voltage of 20.8V (8.4 x 2.5) — it is less than this in practice, due to the 20V supply rail limit.

On the other hand, when the voltage control is at its minimum position (0 ohms), the input will be multiplied by 1+(10/680) or 1.01, causing an output voltage of about 2.5V.



A view of the completed unit. The PCB was mounted to the bottom case using screws, nuts and spacers, due to the lack of mounting pillars in this type of box.

Just as any other op-amp with significant levels of negative feedback, this amplifier 'tries' to maintain the equilibrium at its inputs (pins 4 and 5).

If the supply's output voltage begins to fall due to an increase in load current, the level at the amplifier's inverting input (pin 4) will decrease, while the non-inverting input (pin 5) remains at the stabilised reference voltage. This im-

PARTS LIST

1 PCB 55mm x 114mm, coded 91ps6
1 Plastic instrument case, 160mm x 150mm x 65mm
1 15V AC/1A 2155-type mains transformer
1 1mA/200 ohm MU45-type panel meter, plus new scale artwork
2 DPDT miniature toggle switches
1 SPDT miniature toggle switch
3 Banana-type binding posts (red, black & green)
1 Heatsink, high efficiency fan type, 105mm x 52mm
1 Plastic knob
1 Mains cord and plug

Resistors

(All 0.25W 5% - unless noted)
1 x 18k,
3 x 2.2k,
1 x 1.8k,
1 x 1.2k,
1 x 680 ohm,
1 x 22 ohm,
1 x 10 ohm,
2 x 1 ohm/1W

Variable resistors

1 5k linear-taper pot
1 500 ohm horizontal-mounting trimpot

Capacitors

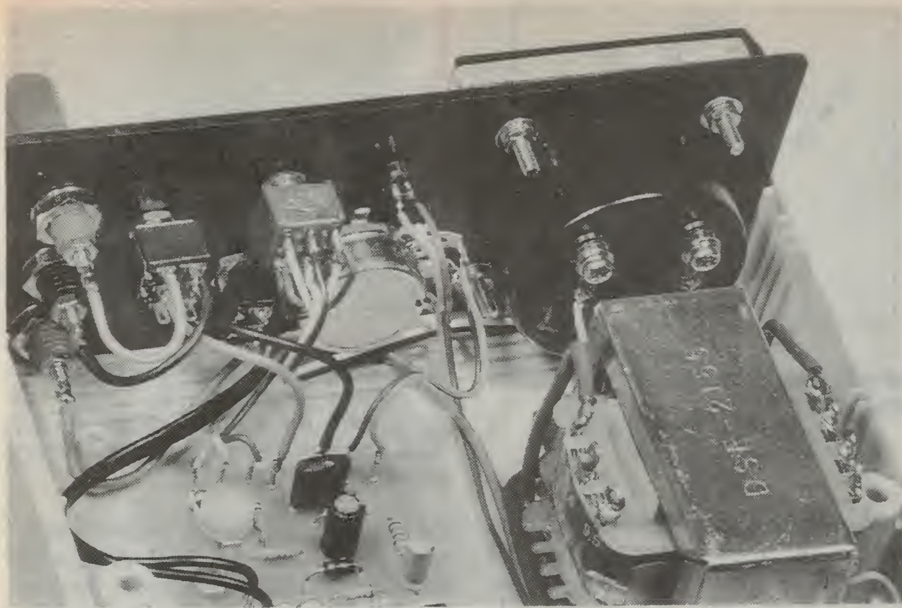
2 2200uF 25V PCB-mount electrolytics
1 47uF 25V PCB-mount electrolytic
1 4.7uF 16V PCB-mount electrolytic
2 0.1uF metallised polyester
1 680pF ceramic

Semiconductors

1 TIP3055 NPN transistor, plus mounting hardware
1 723-type voltage regulator IC (uA723, LM723, etc)
5 1N4002 diodes
1 5mm red LED, plus mounting flange

Miscellaneous

PCB standoffs (14);
rubber grommet to suit mains cord;
plastic P-clamp to suit mains cord;
2-section length of mains-insulated terminal strip (see text);
2 x solder lugs;
heavy and light-duty hookup wire;
small spacers or rubber grommets;
screws and nuts, thermal grease, solder etc.



An inside view of the front panel. The connections from the PCB to the output sockets (via the load switch) should be formed with reasonably heavy-duty hookup wire.

balance causes the output of the error amp to drive high, which increases the drive to transistors A, B and Q1, which in turn tend to pull the output high. Thus the output voltage level is maintained.

Resistors R7, R8 and R9, and IC1's internal transistor C form the supply's current limiting function. With SW1 in the closed position as shown in the schematic, current flows from the emitter of Q1 to the supply's output terminal via the current sensing resistors R8 and R9. When the output current reaches about 1.2A, the voltage developed across R8 and R9 reaches 0.6V (1.2 x 0.5), which is sufficient to bias transistor C slightly on. This in turn bleeds base current away from transistor A, reducing the drive to the remaining voltage follower transistors B and Q1 — as the supply's output voltage and current falls, the bias on transistor C is reduced, and the circuit stabilises at this output current.

A small section of the plastic rear panel must be cut away, so that Q1 can be bolted directly to the heatsink surface. Also note that Q1's legs are connected to the circuit board via PCB stakes.

In practice, this arrangement is very effective. When the current limit point is reached, it's very much a 'brick wall' — that is, the circuit begins to shut down only when the actual limit is reached, and will not allow even a slightly higher current to flow.

The 30mA limit behaves in a similar manner, where the 22-ohm resistor (R7) introduced by SW1 develops the 0.6V drop at a theoretical output current of 27mA (0.6/22).

The remaining section of the circuit controls the output current and voltage metering. With SW2 switched to the current measuring mode (as shown in the schematic), meter M1 is connected in parallel with R8 and R9 via trimpot RV2. In this case the fixed resistors act as a current shunt for the meter, while RV2 adds a variable series resistance so the full scale reading may be accurately adjusted to 1A.

When SW2 is moved to the voltage measurement position, the meter is connected *across* the supply's output terminals, in series with multiplier resistors R10 and R11.

These have been chosen so that 1mA will flow through the meter (for a full scale reading) when the supply's output reaches 20V.

The final few components in the schematic add extra filtering and protection to the circuit. C3 and C7 provide a high frequency bypass for the supply's DC input and output respectively, while C5 connects directly to the 723's internal error amplifier for high frequency compensation. Finally, C6 is included to lower the supply's output impedance (or to filter the output ripple if you like), and D1 protects the circuit against any reversed polarity voltages produced by the load.

Construction

Our new supply is housed in the smallest box in the standard 'plastic instrument case' range, which measures 160 x 150 x 65mm, and is remarkably sturdy when fully assembled. Virtually all of the circuitry is contained on a single circuit board measuring 55 x 114mm and coded 91ps6, while the remaining hardware components (switches, meter etc) are mounted on the front panel. The main series pass transistor (Q1) is bolted directly to a fan-type heatsink, which is in turn attached to the rear panel.

Commence construction by first checking the PCB for any etching anomalies such as broken or bridged tracks, then begin installing the components as shown in the component overlay. Start with the lower-profile

parts (resistors and diodes) and work your way through to the larger components, while taking particular care with the orientation of any polarised devices (the electrolytic capacitors, diodes and IC1).

Note that diodes D1 to D4, and resistors R8 and R9 will dissipate significant power levels, and should be mounted a few millimetres above the PCB so as to promote airflow and assist cooling.

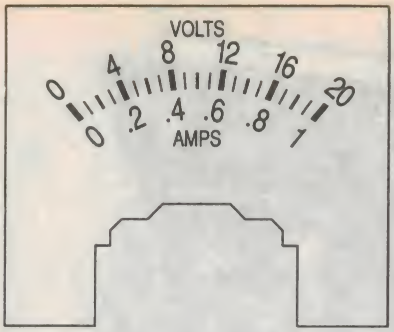
The main filter capacitors on the other hand, should be firmly pushed down onto the PCB before soldering — this prevents any lateral movement, which can ultimately cause the connecting pins to break due to metal fatigue.

PC stakes are used to terminate all external connections, including Q1 (which is not mounted into the PCB) — this makes the final assembly steps much simpler. A total of 16 stakes will need to be installed in the board.

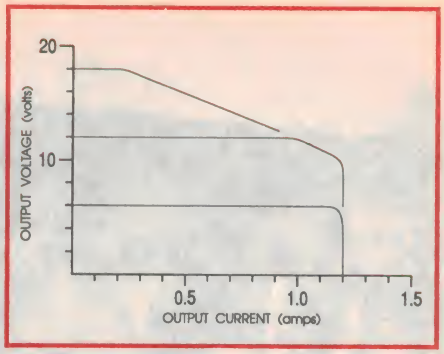
Once the PCB is fully assembled, the meter, voltage adjustment potentiometer, terminals and switches may all be fitted to the front panel, and the rear panel prepared for installation. This requires a hole for the mains cord/grommet, and a (roughly) 25 x 30mm cutout so the series pass transistor (Q1) can mount directly onto the heatsink.

The heatsink itself is a standard 105 x 75mm fan-type, which must be trimmed to around 52mm deep and bolted to the rear panel at its two outermost fins. Fit a solder lug to the mounting bolt nearest the mains cord end of the panel, then Q1 can be bolted in place with its matching mounting hardware.

When installing Q1, check that the mounting hole in the heatsink is free from burrs, then spread a modest



Actual size artwork for the meter scale.



The supply's output current capability at voltage settings of 6, 12 and 18 volts, with the current switch in the 1.2A position. Note the sharp limiting action at 1.2 amps.

amount of heatsink compound on both sides of the mica washer and bolt the transistor firmly in place with the insulating washer on the innermost side — the transistor's legs will need to be temporarily bent away from its body. Finally, use a multimeter switched to the ohms range to check that Q1's metal flange is fully insulated from the heatsink.

Now you're ready to install the transformer and PCB in the bottom of the case. At this stage it should be noted that there appears to be a quirk in the manufacturing process of the instrument case, which is not shared by its two larger brothers in the standard range.

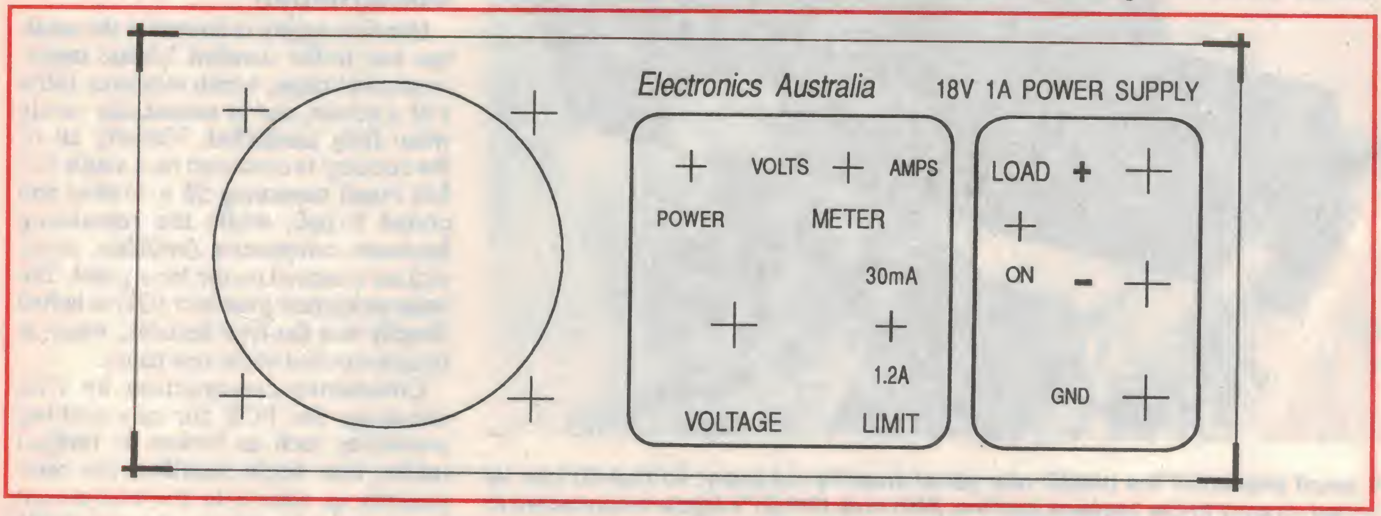
Normally, there are more than 20 mounting pillars moulded inside the bottom half of the case, which allow a circuit board to be secured by small self tapping screws. In the box we have chosen however, the pillars have been moulded into the *lid*, forcing us to mount the PCB by more conventional means — that is, countersunk bolts, nuts and spacers. Not much of a problem really...

The transformer is bolted directly to the base with a solder lug under the rearmost nut, while the PCB should be raised a few millimetres above the bottom panel with the aid of rubber or plastic spacers.

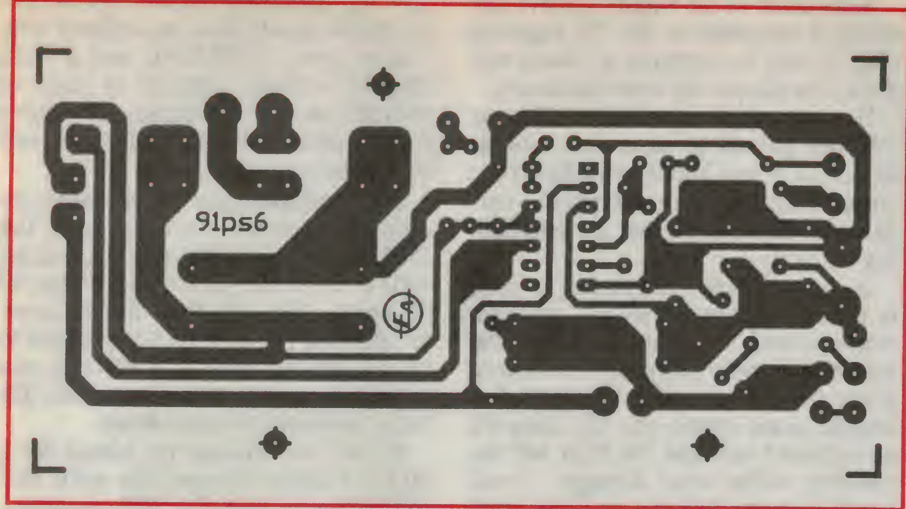
In the prototype supply, we used small rubber grommets for the spacers, and countersunk bolts (with matching countersunk holes in the case) to secure both the transformer and PCB.

Slide the rear panel/heatsink assembly into the lower half of the case, and mount the PCB so that its rear edge just touches the back panel and Q1's legs line up with their matching PCB stakes. Don't solder the legs at this stage.

The 2155-type transformer used in the project is a standard item at the major electronic outlets, however the windings can be terminated in either solder lugs or flying leads (or combinations of both), depending upon the store's current stock line. If the 240V winding has solder lug connections, the mains lead can pass through the supply's rear panel with the active and neutral wires connected directly to the appropriate transformer lugs — which should



The full size front panel artwork, for those who wish to make their own.



This actual size copy of the PCB artwork can be used to make your own circuit board.

then be covered with heatshrink tubing, or insulation tape.

On the other hand, transformers where the primary winding is terminated with flying leads will need to connect to the mains cable via a section of (mains rated) terminal strip — this can be secured to the bottom of the case just behind the transformer, again with a countersunk bolt.

Regardless of the type of transformer, the mains cable should be securely fastened to the case with a plastic P-type cable clamp, and the mains earth lead (green/yellow) soldered directly to the solder lug on the transformer base. Also, a rubber grommet should be installed in the hole in the rear panel, to prevent any chafing of the mains cable.

Once you are satisfied that the mains wiring, transformer and PCB are all correctly in place, the remaining connections can be made. Use reasonably heavy-duty hookup wire for the main DC output wires (via SW3), the current limit switch (SW1) and the transformer-to-PCB connections (if applicable). The remaining internal wiring can be completed with light-duty hookup wire. Finally, tidy up the wiring paths and fit the new scale to the meter face — take care when removing and replacing the meter's cover, since the zero adjustment mechanism can be damaged by rough handling. Also, don't forget to solder Q1's legs to the matching PCB stakes, and make sure that you connect the output ground terminal and heatsink lug to the main earth point on the transformer base.

Setting up, testing

Before applying power to the unit, switch the meter selector to 'volts', the limit switch to '30mA', the load switch 'on', and connect a multimeter to the output terminals. Then turn on the mains supply, check that the power LED illuminates and the 'voltage' control varies the output voltage over a range of around 2.5V to 18V — the supply's own meter should indicate close to the same readings as shown on the multimeter.

If there is a significant error in the supply's meter readings, double-check that the correct resistors have been installed as R10 and R11. On the other hand, a small (but significant) error may indicate that the meter movement does not quite match its 1mA/200 ohm rating. In this case, a (say) high meter reading can be corrected by raising the value of R11.

Once you are happy with the supply's voltage function, select 'amps' with the meter switch and apply a short circuit between the output terminals. If the 30mA current limiting facility is operating correctly, you should notice only a small reading on the meter (in fact, about 30mA) — a full scale reading would indicate that SW1 is wired incorrectly.

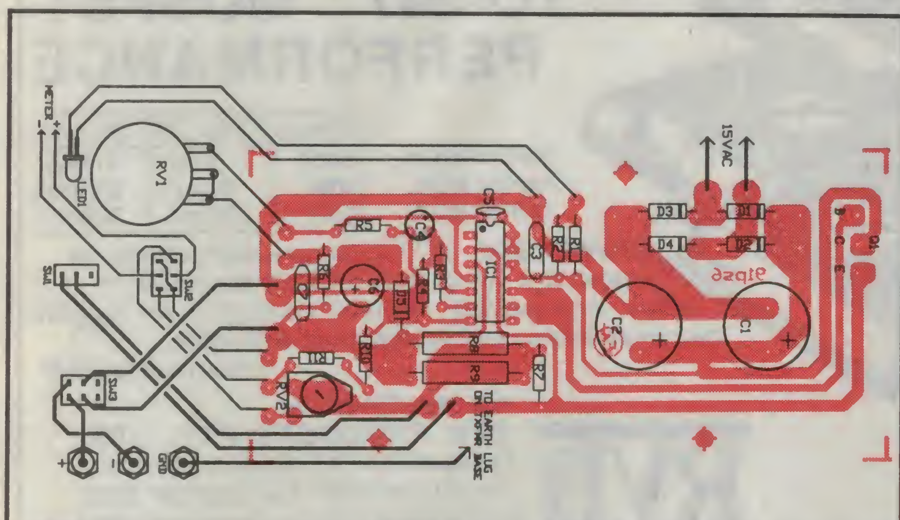
Next, turn the load switch off, and connect a load and multimeter in series between the supply's output terminals — a 5.6 ohm/10W resistor is quite a suitable load. Configure the multimeter to read current (say, on a 2A range), select 1.2A on the supply's limit switch and turn the load switch on. The meter should now show that a substantial current is flowing.

The current meter can now be calibrated by adjusting RV2 on the PCB so that the supply's meter reading matches that of the multimeter. Since the output current is proportional to the output voltage with a resistive load, you should be able to check the meter readings at say 0.5A and 1A by simply adjusting the supply's voltage control. Bear in mind however, that the readings are unlikely to be exactly linear, due to the electro-mechanical nature of the meter movement.

Finally, you can check the supply's regulation by observing the drop in output voltage as a load is connected. Select 'volts' on the meter switch, turn the load switch off and adjust the output voltage to say 5.6V (if the load is 5.6 ohms). Now switch the load on while watching the voltage reading on the supply's meter — the reading should not deviate, despite the 1A load current.

Fault finding

In the unhappy event that your supply does not perform as expected, it's time to don the thinking cap and perform a few tests.



Refer to this component overlay and wiring diagram during construction. Take particular care with the orientation of any polarised components.

When trying to solve a problem with any project, there really is no substitute for understanding how the circuit actually works — without this knowledge, it's an uphill battle all the way.

Fortunately our new power supply's operation is quite straightforward, so by studying the foregoing circuit description, you should be able to trace any fault condition in a short time. Note that a number of voltage readings have been included in the circuit diagram — these apply to an output voltage setting of 10V, with the load *disconnected*. When load current *is* flowing, virtually all of the circuit voltages will change.

Any problems with the supply will tend to be caused during the construction stage, and can usually be traced to incorrect component values or placement, or a simple wiring error — so it's always worth double checking your work before applying power, and starting at this point when faultfinding at a later stage.

If the power LED doesn't illuminate for example, the most likely cause is that it has been connected with a reversed polarity, or the rectifier diodes (D1 to D4) has been installed incorrectly.

Since most of the supply's active circuitry is contained in the 723 regulator chip, it will be tempting to blame this device for almost any error that occurs.

However, like most current ICs, the 723 has proved to be a very reliable device — if you haven't installed it the wrong way around or shorted the output pins, chances are that it's functioning correctly.

In short, the best fault finding method is to take a series of voltage measurements around the circuit, compare the readings to those published and deduce where the problem might be. Don't dive straight in and replace the 723, since it's an awkward task and the PCB will invariably suffer some damage — and you'll probably find it wasn't the problem anyway.

Modifications

When developing the circuit and PCB for this power supply, we decided that its capabilities should be a little more open-ended than other designs. The result is that the unit's output current and voltage capabilities can be increased by using a larger power transformer, and altering just a few circuit components.

To increase the maximum output current for example, the transformer can be changed to a 2156-type, which offers a 15V AC secondary rated at 2A. Diodes D1 to D4 should then be replaced with 3-amp types (1N5404), and a 0.22 ohm/5W resistor installed in place of both R8 and R9. Of course, the meter's current scale and FSD calibration will need to be corrected.

The remaining circuit components are quite adequate — for example the TIP3055 has a healthy 60V/15A rating with a maximum power dissipation of 90 watts. Also, the PCB has been arranged with sufficiently heavy tracks to cope with the increased current, and enough free area to accommodate the larger replacement components.

If you wish to alter the circuit for a higher output *voltage*, the only real limitation is that the 723 regulator chip has a maximum supply rail rating of 40V.

In this case, a 6672-type transformer is quite suitable if the 24V AC secondary tap is used — this will generate an unregulated source voltage of around 34V DC, and a maximum output of about 32V at the supply's terminals.

In this case, capacitors C1, C2 and C6 will need to have a voltage rating of 35V (or more), and the meter's scale and limiting resistors (R10 and R11) changed to suit the increase in maximum output voltage. ■

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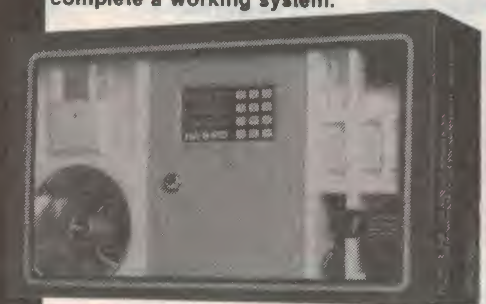

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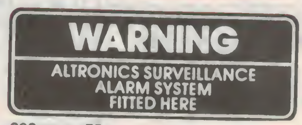

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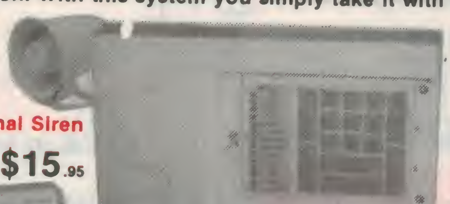

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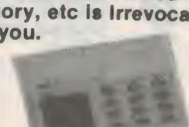

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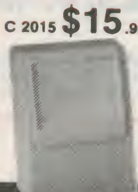

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Construction Project:

IMPROVED SERIAL I/O INTERFACE FOR PC'S - 2

Following on from the basic interface unit described in the first of these articles, we now look at the simple PCB modules used to provide it with isolated monitoring inputs and control outputs. Some simple software examples are also provided, showing how easy it can be to use your PC for this kind of application.

by JIM ROWE

As you no doubt gathered from last month's article, the basic interface module simply provides a set of eight TTL output lines, each of which can be individually set to a high or low logic level by the PC — via its serial port.

Similarly it provides a set of eight TTL input lines, whose levels can be sensed at any time by the PC, again via the serial port. And to allow for more than eight outputs and inputs, if required, the module is 'addressable' so that up to eight of them can be connected to the one serial port.

Of course for a lot of situations where you want to use a PC for controlling or monitoring things, providing a suitable number of addressable TTL output and input lines is only half the story. Generally it's also necessary to use *output driver* circuits, based on switching devices such as relays or triacs, so that the low-power TTL outputs can be made to control things like motors, lamps, sirens, actuators or heaters.

Similarly on the input side, you frequently need to use *input buffering* circuits, to convert 'real world' voltages and currents into corresponding TTL signals, so they can be handled by the interface.

In most cases, an inportant additional function of these output drivers and input buffering circuits is to provide *isolation*, to protect both the basic interface and the PC itself from possible damage due to high voltages and/or currents.

In this second article, we'll be looking at two output driver modules for use with last month's basic interface. One of the output drivers uses relays, for controlling low voltage DC and AC, while the other uses triacs for controlling devices which operate from 240V AC. There's also an input isolating buffer, which accepts low voltage DC or AC voltages or currents.

All three modules are low in cost and easy to build, in line with the interface itself. Using them in suitable combinations, you should be able to use the interface with your PC to monitor and control a very wide range of devices and/or equipment.

Incidentally I can't claim any originality for these modules. Two of them, the relay driver and input buffer, were originally designed by Mark Cheeseman and described by him in the February 1989 issue, as part of his 'Real World Interface'.

Only the third (triac) module is new, but even here it's essentially only a minor revamp and update of Mark's earlier unit — to allow easier programming and better fail-safe operation, and also to make it more compatible with components that are now available.

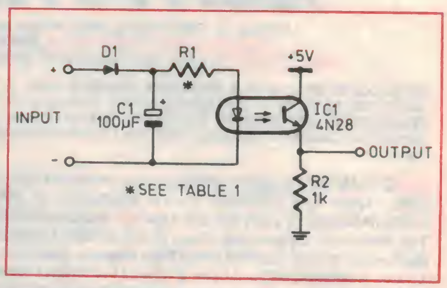


Fig.1: The circuit for each channel of the opto-isolator input buffer card. Table 1 overleaf gives values for R1.

Input buffer

The input buffer module is basically a small PCB coded 88rw12a, measuring 125 x 55mm and designed to provide up to eight identical opto-isolated input buffers using the schematic of Fig.1. Here a low cost 4N28 optocoupler is used to provide the necessary isolation (7.5kV), with its output phototransistor connected as a simple switch between the +5V rail (from the main interface) and one of the interface's UART input lines.

When the phototransistor conducts, in response to receiving light from the internal LED, it thus produces a TTL logic high or '1' at the UART input. Conversely when light is not received, the phototransistor remains off and the voltage at the UART input is pulled down by R2, to TTL logic low or '0'.

To achieve this switching action, the 'real' input signal merely needs to turn the optocoupler's LED on and off — which involves a current of around 8-10mA. Resistor R1 can be adjusted in value to provide this order of current with any desired value of DC input voltage from about 3V to 24V, or even larger if a higher-wattage resistor is used. Similarly if diode D1 and capacitor C1 are added, the circuit can be arranged to respond to AC signals in the same range, as well as DC. Table 1 can be used as a guide to selecting the value of resistor R1, to suit the input signals to be monitored in your particular application.

For signal voltages higher than 24V DC/17V AC, calculate the value of R1 using Ohm's law, to produce a round 8-10mA. And don't forget to calculate the likely power dissipation in R1 as well, and use a resistor with the appropriate rating.

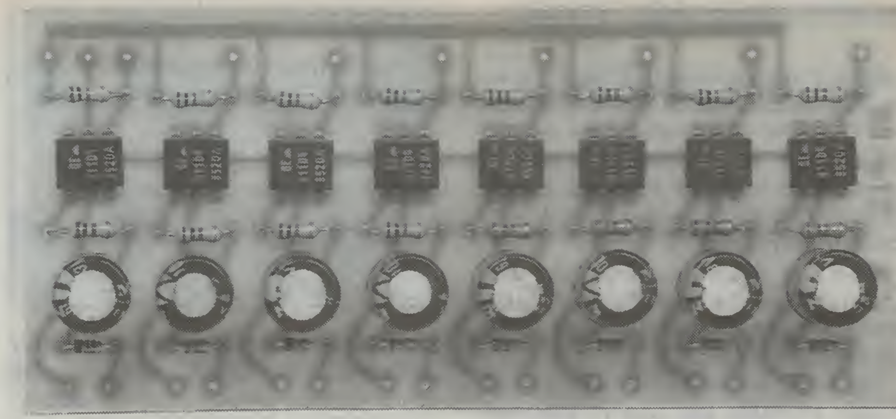
For example if you need to monitor the output of a 150V DC power supply, you'll need to give R1 a value of around 15k — but as it will need to dissipate 1.5 watts, you'd be advised to use a 5W component.

For AC signals, multiply the RMS signal voltage by 1.41 before you work out the value for R1 needed to give 10mA. This is to allow for the fact that D1 and C1 will tend to act as a peak-responding rectifier. And here it will also be necessary to select suitable components for C1 and D1, to cope with the peak and peak-to-peak values of the input voltage, respectively. For example if your AC input signal to be monitored is 30V RMS, C1 will need to be rated for 45V operation (i.e., a 50V type), while D1 should be a 100V diode.

For monitoring very high voltages, it may be necessary to split R1 into two separate series resistors, to obviate the need for an expensive high voltage capacitor. The larger of the two resistors would go directly in series with D1, ahead of C1, with the smaller in the present R1 position so that they form a voltage divider as far as C1 is concerned.

The wiring of the input buffer module should be fairly clear from the photograph and PCB overlay diagram. The PCB pattern is also reproduced again, for those that wish to etch their own, although boards are already stocked by PCB makers such as RCS Radio.

Note that the 88rw12a board provides a thin copper track shorting out the 'D1' connection pads for each input. This is to save you having to fit a wire link in place of the diode, if you wish to wire the buffer up for use only with DC input signals. If you fit D1 and C1 to allow for AC signals as well, simply cut each of the small 'link' tracks with a sharp scalpel.

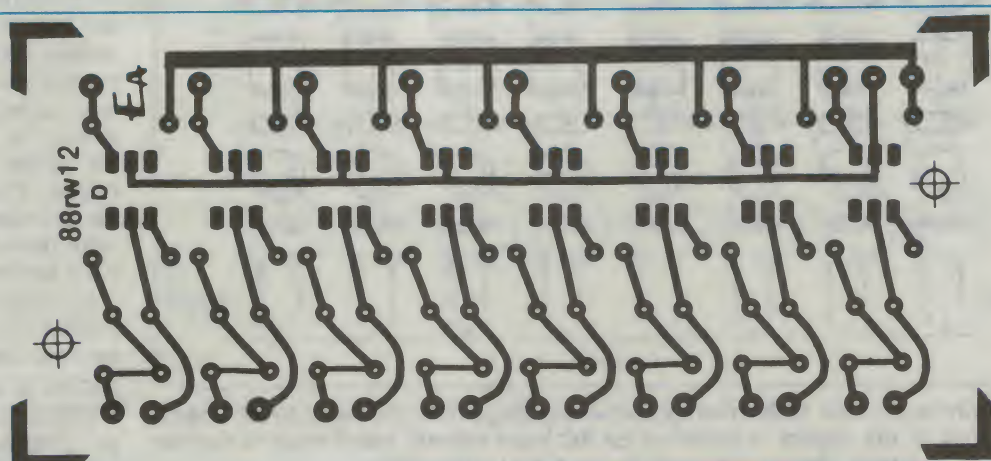


Top view of the input buffer card with all eight channels wired up for AC input signals. The input connection pads are at the bottom, with outputs to the main interface unit along the top.

Relay driver

The relay driver output module is built on another small PCB, measuring 77 x 56mm and coded 88rw12b. This module has provision for up to four relay driver stages, each using the simple circuit shown in Fig.2.

Each driver stage has BC338 or similar transistor Q1, whose base is driven from a TTL output line of the



Here's the PCB pattern for the input buffer board, reproduced actual size.

interface module via a 1.5k series resistor. The collector of Q1 is connected to a +12V supply (or possibly the unregulated output of the plug-pack used to power the interface) via the coil of relay RL1, so that the relay is activated when the transistor conducts.

Diode D1 is used to protect the transistor from the inductive 'spike' developed across the relay coil, when the transistor turns off.

The board is designed to take a small, readily available low cost PCB-mounting relay, with a SPDT contact set rated at 5A. This type should be suitable for most general purpose switching in low voltage circuitry. If you need to control larger currents, probably the best approach would be to use the small relays to control suitably larger relays — as the latter will almost certainly have coils requiring more current than the BC338's are capable of handling.

Alternatively you could use larger relays instead of those shown, mounting them off the board and connecting them via hookup wire. But if this is done, you should also use a Darlington transistor like the BD681 in place of the BC338, to ensure that it can handle the higher coil current without coming out of saturation. The BD681 has different connections to the BC338 though, so you'll need to be careful.

If you need to control more than four output circuits, the idea would be to build more than one of the relay driver modules. Note, though, that the relay driver module should NOT be used to switch 240V mains AC. It's not designed to do so, and due to the close spacing between the coil connections and contact tracks on the PCB, there would be a risk of flashover. If you need to switch 240V, the triac module should be used.

TABLE 1

Values for R1 in input buffer:

DC	AC	R1
3V	2V	180 ohms
4.5V	3V	330 ohms
6V	4.5V	470 ohms
9V	6V	820 ohms
12V	9V	1k
16V	12V	1.5k
24V	17V	2.2k

Assembly of the relay driver module should be straightforward using the photo and wiring diagram as a guide. The PCB pattern is again provided for those who etch their own. Note that the board is designed to take PCB-mount terminal blocks for the switched connections, to make it easier to wire everything up.

Triac module

The triac output driver module is built on a somewhat larger PC board, measuring 166 x 126mm and coded 88rw12d. (This board is intended to replace Mark Cheeseman's original 88rw12c board, by the way, at least as far as the current I/O interface is concerned — that's the reason for giving the new board a code which corresponds to December 1988, rather than August 1991.)

The module provides for up to four triac switching circuits. There are two reasons for the relatively large board size, one being that each triac needs to be fitted with a reasonably large heatsink to prevent overheating when handling higher currents. The other reason is that the board has to provide sufficient track and component spacing to cope with safety and isolation requirements.

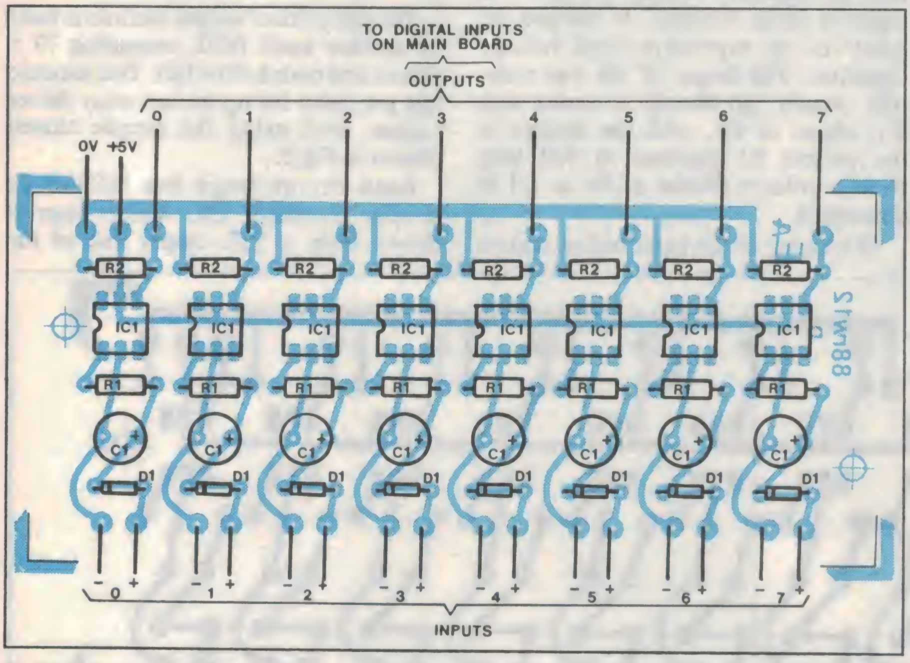
The circuit for each triac switch is shown in Fig.3. As you can see, an MOC3021 opto-coupled triac U1 is used to provide the primary isolation between the interface output and the 240V mains. The MOC3021 itself is rated at 7.5kV peak isolation, and while the minimum track spacing between the mains wiring and 'input' sides of the board (at the opto-coupler) is only 4mm, this should still be sufficient to cope with all likely mains transients — apart from those caused by a nearby lightning strike.

The input LED of the MOC3021 is driven by a TTL output from the interface, with series resistor R9 used to set the drive current level. An external LED is also connected in series, to provide local indication of the circuit's switching state. This allows you to see at a glance which loads are 'on' or 'off', even when the loads themselves are some distance away, or perhaps not self-indicating (like a heater element).

The input wiring is arranged so that the MOC3021 diode conducts when the TTL input line from the interface is taken 'high'. This is the main difference between the new triac module and the original, which had the input drive signal sensing reversed.

Why the change? Well, Mark Cheeseman's original interface unit used 'LS' TTL output devices, which could only provide sufficient current to drive the optocoupler diode when they were *sinking* current, in the 'low' state. Hence he was more or less forced to make this state correspond to the 'on' state of the triacs. He was however also able to use Q-bar outputs from the interface output devices, to ensure that when the interface logic was reset, all triacs were turned off — a desirable arrangement for safety.

In contrast with LS TTL, the 74HC259 CMOS device used in our new interface unit can provide sufficient current to drive the MOC3021 diode in the 'high' logic state. Conversely, it has no Q-bar outputs available; only Q outputs. And although the interface allows



Fairly obviously, this is the overlay and wiring diagram for the input buffer board. Note that if the board is wired up for AC input signals, you'll need to cut the small PCB tracks linking the pads for each 'D1' input diode.

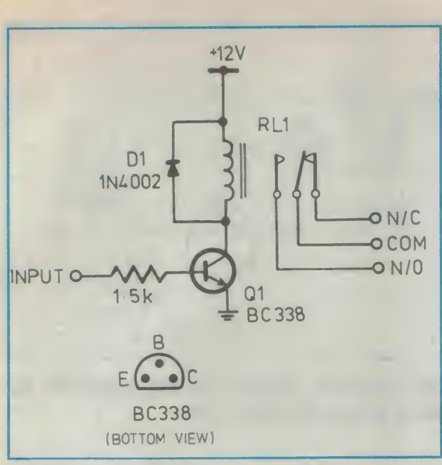


Fig.2: The schematic for each relay output driver stage.

And here's a top view of the relay output driver board, with all four relay channels wired up. The input connections from the main interface are along the bottom.

for software programming of each output bit line to either the high or low state, so that it *can* in theory be used with the earlier triac module, this has one drawback: when power is first applied to the interface, or it is reset, the output lines will all go low — which with the old triac module, will cause all triacs to turn on.

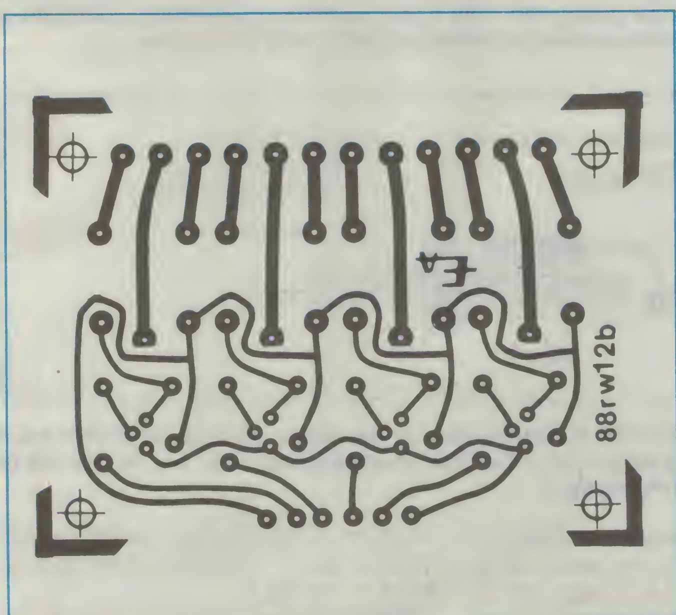
You can of course arrange for your software to turn them all off again very quickly, but it's hardly the ideal arrangement from a safety point of view. Hence the decision to produce the modified design, with 'high=on' input sensing and all triacs turned off following a power-up or reset.

The output triac element of the MOC3021 is used in turn to switch the main triac T1, which can be any of the readily available mains-rated 6A or better triacs in the T0-220 package, such as the SC141D, BT137, TIC216D/E or TIC225D/E. Resistors R1/R2 and capacitor C2 form a 'snubber' circuit for the triac section of U1, to ensure that it turns off correctly at the end of the current AC half-cycle when the input LED turns off. By the way the values of the snubber components are slightly different from those used in the original triac module, to allow use of a 47nF capacitor. These are somewhat more readily available nowadays than the value specified previously.

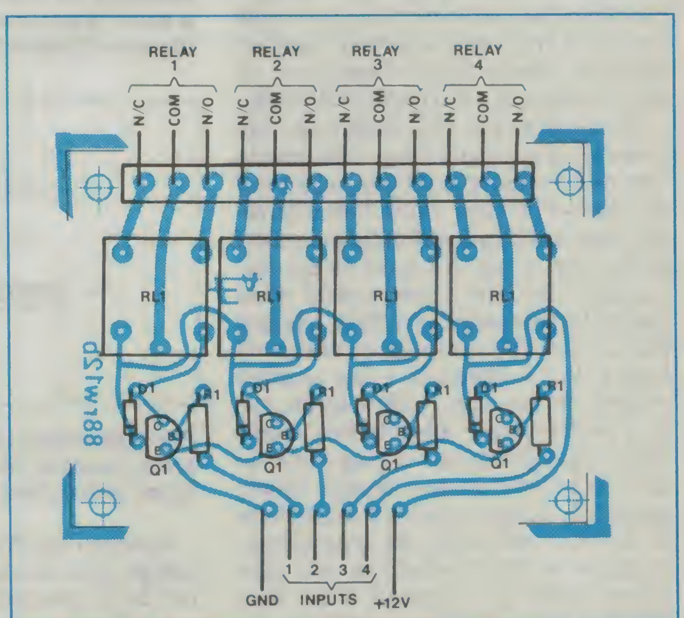
Note that it is most important to use a capacitor rated for 250V AC operation — even 630V DC-rated polyester caps have been known to fail in this kind of circuit. The new PCB is designed to take the 250V AC type currently available, with 0.6" lead spacing.

As shown, each switching circuit of the triac module is kept separate from the others, so that if necessary they can be used to switch loads connected to different supply circuits. Each is also provided with its own protection fuse, in series with the active line input. A fuse rated at 5A is probably the most appropriate for the SC141D triac, when used to switch most typical loads.

Wiring of the triac module itself



Voila! No prizes for guessing that this is the etching pattern for the relay output driver board...



...Nor for guessing that this is the overlay and wiring diagram for the same board.

should again be straightforward, using the overlay diagram and photo as a guide. But as this module is involved in switching the 240V mains, it's important to realise that the triacs and their associated components and wiring pose a potential safety hazard.

The complete module should therefore be enclosed in a suitable case — either an earthed metal case as shown, or a plastic case which provides effective double insulation.

The aluminium and steel case shown measures 255 x 155 x 77mm, giving plenty of space to mount the PCB in the centre, with adequate space around it. The board is mounted via 25mm-long insulating spacers, as an extra precaution.

The four cartridge-type mains rated fuseholders are mounted on the rear of the case, along with the four 3-pin outlets for the loads. The mains input cable also enters via the rear, through a grometted hole. The only item on the front panel which is connected to the mains is a neon pilot lamp, enclosed in an insulating plastic housing.

The connector for the low-level input signals from the interface unit is also mounted on the front panel, along with the four indicator LEDs in their bezels. This allows all of the low-level wiring to be kept short, and away from the 'hot' wiring.

We used an insulated 5-pin DIN socket for the signal input connector, but almost any suitable small connector could be used instead. A DB-15 connector matching that on the interface unit could be used if you want to fit two of the triac modules into a single larger case, to allow control of a full eight 240V loads.

Needless to say you should also observe all of the usual safety precautions. The mains cable should of course be of the three-wire type, fitted with a three-pin plug and clamped firmly upon entry to the case, to prevent strain on the connections; the active and neutral wires should be terminated in a 'B-B' terminal block, while the earth wire should be left longer and soldered to a lug attached reliably to the case, with a screw, nut and lockwasher; all internal mains wiring should be made in properly insulated wire, and passed through rubber grommets where it passes through holes in the case; and finally, the exposed connections on the fuseholders and pilot lamp should be covered with 'heat shrink' plastic sleeving, to minimise the risk of accidental contact when the case is opened.

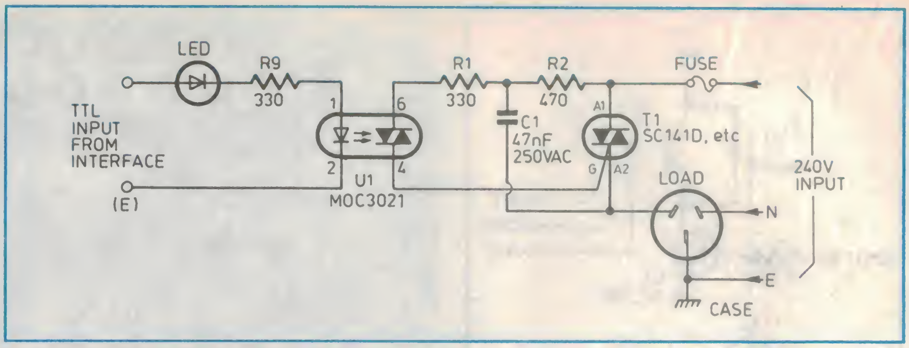
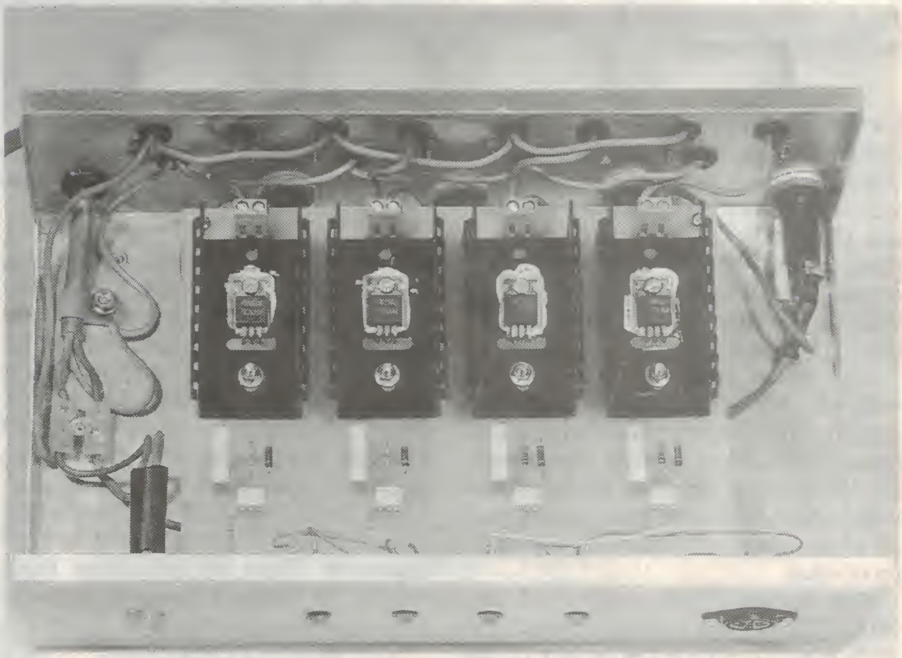


Fig.3: The schematic for each channel of the triac output driver module. An MOC3021 opto-coupled triac driver is used to provide isolation.



Because the triac output driver module operates at 240V, it should be housed in a suitable enclosure for safety. We built it into a earthed metal case, taking all of the usual precautions to prevent accidental contact with the mains.

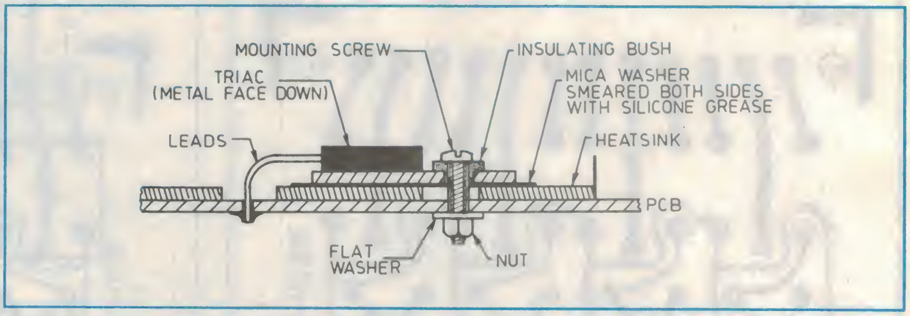
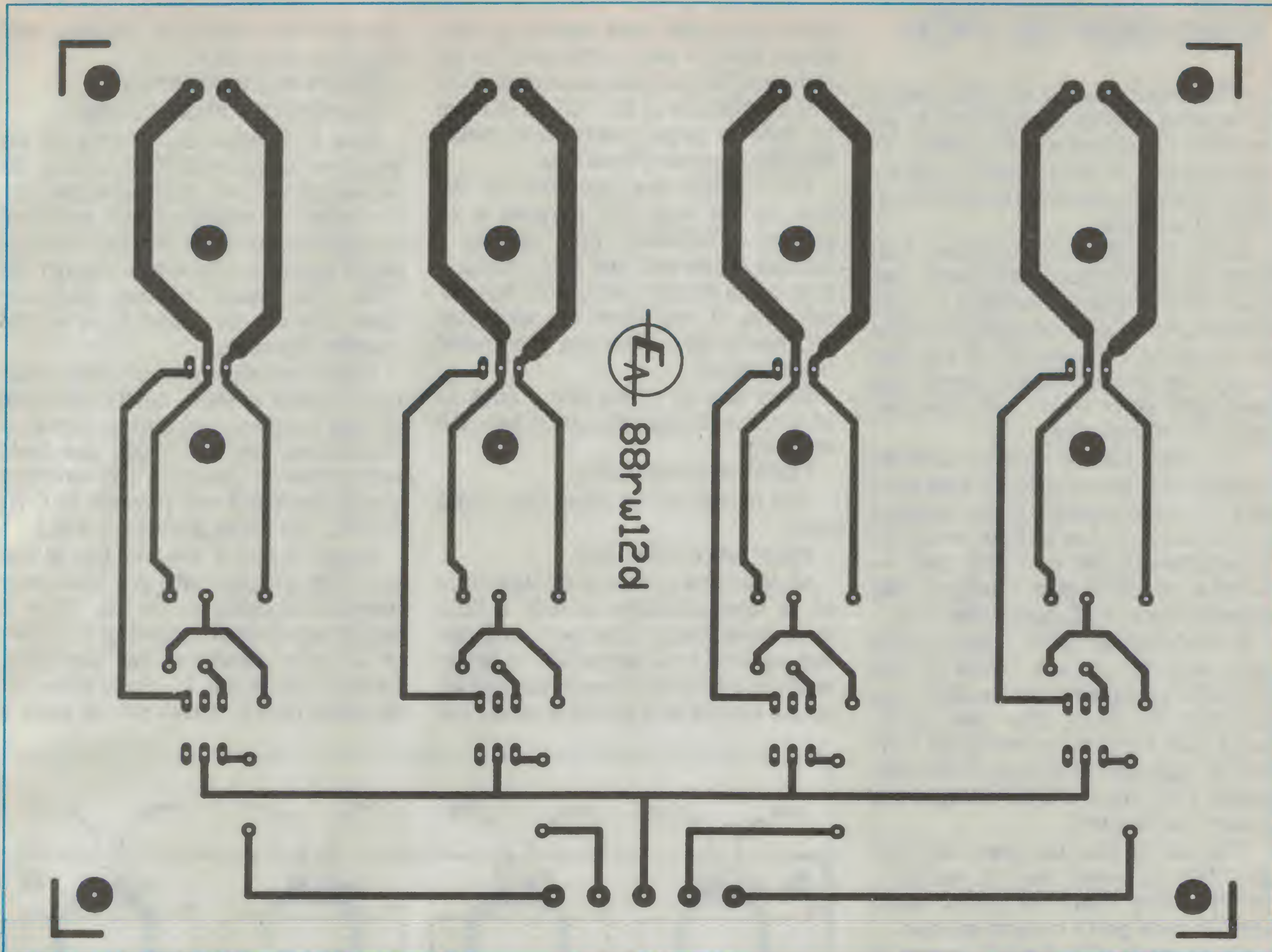


Fig.4: Mounting details for the triacs used in the above module. Note that each metal heatsink is insulated from the 'live' triac mounting tab, but is allowed to 'float' rather than being earthed.

Although the PC board is designed so that the triac heatsinks can operate at the full 240V potential if necessary, this is not particularly desirable from a safety point of view. I suggest that you insulate each triac from its heatsink using a rectangular mica washer, smeared with silicone grease to ensure a good thermal bond — see Fig.4.

If you do this and also insulate the triac mounting screw with one of the small plastic bushes sold for the pur-



Again, no prizes for guessing that this is the PCB pattern for the triac output driver module, actual size.

pose, this should allow each heatsink to 'float' at a high impedance, with a potential determined mainly by the triac-heatsink coupling capacitance (via the mica washer).

The mounting screws will also be floating, with the only fully 'live' parts then the triacs and the snubber components. Should anyone accidently brush against one of the heatsinks they'll probably still get a 'tingle', but without a serious or fatal result.

By the way it would *not* be advisable to earth the heatsinks. This would place a significant stress on the mica washer, and there would probably be a risk of breakdown. Allowing the heatsinks to 'float' is the best compromise between safety and reliability.

PARTS LIST

Input buffer board

- 1 PC board, 88rw12a
- 8 4N28 optocouplers
- 8 1k 1/4W resistors
- 8 1/4W resistors (see Table 1)
- 8 100uF 35VW electrolytic (optional)
- 8 1N4148 diodes (optional)

Relay driver board

- 1 PC board, 88rw12b
- 4 1.5k 1/4W resistors
- 4 BC338 transistors
- 4 1N4002 diodes
- 4 SPDT PCB mounting relays
- 4 3-way PCB mount terminal blocks

Triac module, case

- 1 PC board, 88rw12d
- 8 330 ohm 1/4W resistors
- 4 470 ohm 1/4W resistors
- 4 47nF 250V AC capacitors
- 4 MOC3021 triac optocouplers
- 4 SC141D or similar TO-220 triacs
- 4 TO-220 heatsinks, 60 x 36 x 30mm
- 4 2-way PCB mount terminal blocks
- 4 TO-220 insulating washer kits
- 5 PCB connection pins
- 1 Case 255 x 155 x 77mm or similar case
- 4 25mm insulating spacers, tapped
- 4 3-pin mains sockets
- 4 3AG fuse holders with 5A fuses
- 1 5-pin DIN socket, insulated
- 1 240V neon pilot lamp/bezel

Mains cable and three-pin plug;
mains terminal block;
cable clamp;
solder lug;
rubber grommets;
3mm nuts and bolts;
heat-shrink sleeving;
connecting wire, solder, etc.

Software

As the interface and its buffer/driver modules connects up to your computer via a standard RS-232C serial communications port, monitoring its inputs and controlling its outputs requires only very simple programming.

For most purposes it can be done simply and effectively using standard BASIC, although those who are into a more flexible language like 'C' or assembler can of course use such languages if they need to achieve the ultimate in speed.

The basic idea is that the status of each output line of the interface/driver setup

Interface for PCs

can be programmed at any time, simply by sending a single control byte to the interface via the serial port to which it's connected. The data format used for these 'control bytes' was shown in Fig.1, in the first article.

Similarly to monitor the levels of all eight of the interface/buffer inputs, you again simply send the interface a single control byte — with the right code (also shown in Fig.1 last month). It will then 'reply' by sending back a single data byte, each bit of which will reflect the status of one input line.

The exact method used to send the control bytes and receive the data bytes will of course depend on the language you're using, and to a lesser extent the architecture of the computer itself — whether the serial port is mapped into memory space or I/O space, and so on.

If you're using BASIC, the simplest way may be to use PRINT# and INPUT# statements for sending and receiving the bytes, after opening the serial port. Or if you're using the GW-BASIC supplied with many IBM-compatible PC's, the INPUT$ statement can be used for receiving.

With earlier 8-bit machines, the OUT and INP statements may be easier, or perhaps using POKE and PEEK to access the serial port's memory address.

Using simple GW-BASIC statements to illustrate the basic idea, the first statement you'd need would be something like this, to open the COM1: port for use:

OPEN"COM1: 9600,N,8,1,CS0, DS0,BIN" AS #1

Here the various parameters specify the baud rate your interface is set for, that no parity is to be used, that there will be eight data bits per serial character, with one stop bit, that no delay is required for timeout sensing of the CTS and DSR handshaking lines, and that binary data is to be exchanged. Similarly the 'AS #1' at the end indicates that the COM1: port is to be allocated to data buffer number 1. If that buffer was already in use, you'd specify another; similarly if the interface was connected to another serial port, you'd specify COM2: or COM3: — and so on.

After the port has been 'opened for business', all you need to change the state of a particular output line on a particular interface unit is the statement:

PRINT #1,CHR$(A + (8*B) + (16*C) + 128);

Where A is the code number for the output line concerned (0-7), B is the data to be sent to the latch flipflop for that output line (0 = off, 1 = on), and C is the address of the interface concerned (0-7). The significance of the '128' is to make the byte an *output* control byte, rather than one requesting input data.

Don't forget that semicolon on the end, by the way. It's purpose is to prevent GW-BASIC from sending a carriage return and line feed combination out to the port, along with the control byte. If you leave the semicolon off, you'll quite often get unexpected 'extra' events!

So to turn on output line 3 (code 2) of interface 1 (code 0), you'd have the statement:

PRINT #1,CHR$(138);

And to turn off the same line, you'd have:

PRINT #1,CHR$(130);

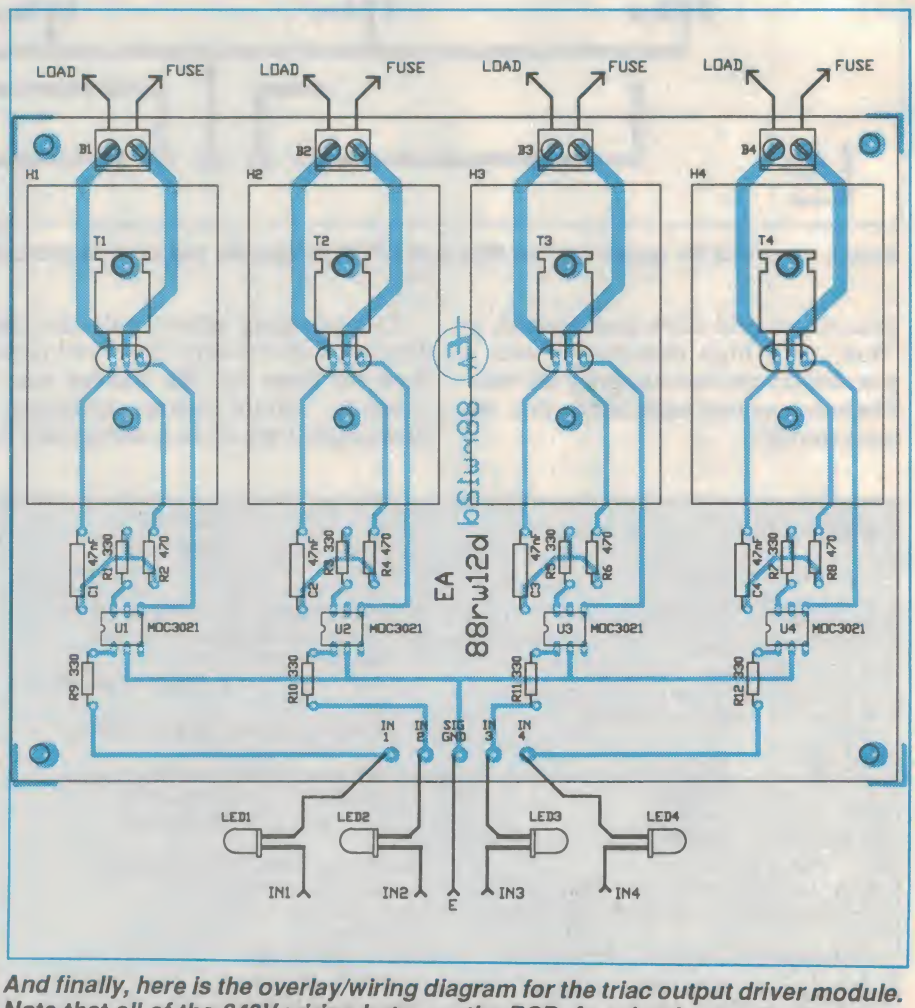
Monitoring the status of the input lines of an interface/buffer is only a little more complicated. Here you need two statements in rapid succession — one to send the control byte requesting the interface to send back the input status, and the other to 'catch' the resulting data byte that comes back:

PRINT #1,CHR$(16*C);
I$=INPUT$(1,#1):I=ASC(I$)

Here C is again the address of the interface concerned (0-7). After the second of the two statements has run, the value of variable I will represent the input status of the interface lines — added together, as a single number (0-255). The status of any particular input line can be found by a simple masking algorithm.

To save you the hassle of writing your own program to check out the operation of your interface, and also to provide a 'foundation' on which you can build more elaborate programs, I've written a simple functional test program in GW-BASIC. The listing is shown in Fig.5.

As you'll find if you key this in and run it, the program asks you how many interface modules are in use. Then it begins automatically scanning the inputs of all active interfaces, and displaying these on the screen in binary form. At the same time it invites you to press a



And finally, here is the overlay/wiring diagram for the triac output driver module. Note that all of the 240V wiring between the PCB, fuse holders, output sockets and mains input cable termination block should be made in mains-insulated wire.

```
10 CLS:KEY OFF:DEFINT A-Z:SCREEN 2:WINDOW SCREEN(0,0)-(639,199)
20 LINE(0,0)-(639,199),,B:LOCATE 2,10:PRINT"EA RS-232 I/O SYSTEM TEST PROGRAM";
30 LOCATE 2,60:PRINT"VERSION 1.00";
40 LOCATE 18,5:INPUT"How many modules are connected (1-8)";N
50 IF N<1 OR N>8 THEN 40 ELSE LOCATE 4,5:PRINT"Modules in use:";N;
60 OPEN"COM1: 9600,N,8,1,CSO,DSO,BIN" AS #1:A=16:N=N-1
70 LOCATE 4,32:PRINT"Input lines:      8  7  6  5  4  3  2  1";:LINE(375,35)-(58
0,110),,B
80 FOR B=0 TO N:PRINT #1,CHR$(A*B);:I$=INPUT$(1,#1):GOSUB 1000
90 LOCATE(6+B),5:PRINT"Current input line status (module ";(B+1);"):";
100 LOCATE(6+B),49:PRINT S;T;U;V;W;X;Y;Z;
110 LOCATE 18,5:PRINT"Press any key to change an output line...";
120 K$=INKEY$:IF K$<>"" THEN GOSUB 500
130 NEXT B:GOTO 80
140 REM
500 GOSUB 750:LOCATE 18,5:INPUT"Which module to be addressed (1-8)";B:B=B-1
510 IF B<0 OR B>N THEN 500
520 LOCATE 20,5:INPUT"Which output line to change (1-8)";P
530 IF P<1 OR P>8 THEN 520 ELSE P=P-1
540 LOCATE 22,5:INPUT"Turn it ON (1) or OFF (0)";C
550 IF C<>1 AND C<>0 THEN 540 ELSE C=C*8
560 PRINT #1,CHR$((A*B)+P+C+128);:GOSUB 750:RETURN
570 REM
750 Q$=SPACE$(45):FOR J=18 TO 22 STEP 2:LOCATE J,5:PRINT Q$;:NEXT J:RETURN
760 REM
1000 S=0:T=0:U=0:V=0:W=0:X=0:Y=0:Z=0:I=ASC(I$)
1010 IF I>127 THEN S=1:I=I-128
1020 IF I>63 THEN T=1:I=I-64
1030 IF I>31 THEN U=1:I=I-32
1040 IF I>15 THEN V=1:I=I-16
1050 IF I>7 THEN W=1:I=I-8
1060 IF I>3 THEN X=1:I=I-4
1070 IF I>1 THEN Y=1:I=I-2
1080 IF I=1 THEN Z=1
1090 RETURN
```

Fig.5: The listing for a simple functional test program for the I/O interface and its driver modules written in standard GW-BASIC.

```
10 CLS:OPEN "COM1: 9600,N,8,1,CSO,DSO,BIN" AS #1:PRINT"Light Flasher"
20 PRINT:INPUT "Which module (1-8)";B:B=B-1
30 PRINT:INPUT "Which line to flash (1-8)";P:P=P-1
40 PRINT #1,CHR$((16*B)+P+8+128);:GOSUB 100
50 PRINT #1,CHR$((16*B)+P+128);:GOSUB 100
60 B$=INKEY$:IF B$=""THEN 40 ELSE 30
100 FOR X=1 TO 500:NEXT X:RETURN:REM Adjust X for flash rate
```

Fig.6: An even simpler program in GW-BASIC which can be used to flash a lamp or lamps connected to any channel of the triac output driver module.

```
10 CLS:OPEN "COM1: 9600,N,8,1,CSO,DSO,BIN" AS #1:PRINT "Simple Light Chaser"
20 PRINT:INPUT "Which module (1-8)";B:B=B-1
30 PRINT:INPUT "How many lines to use (1-8)";P:P=P-1
40 FOR Z=0 TO P
50 PRINT #1,CHR$((16*B)+Z+8+128);:GOSUB 100:PRINT #1,CHR$((16*B)+Z+128);
60 NEXT Z
70 B$=INKEY$:IF B$=""THEN 40
80 GOTO 30
100 FOR X=1 TO 500:NEXT X:RETURN:REM Adjust X for chasing rate
```

Fig.7: Only slightly fancier is this program which can be used to turn the triac module into a simple 'light chaser'...

key, if you wish to change the status of any output line. If you accept the invitation and press a key, it will then ask you to specify the interface module to be addressed, which of its output lines you want to change, and whether you want it turned on or off. Then when you input the last requested item, it will send the appropriate output control byte to change the nominated output line, and return to scanning the inputs.

By the way, the program does make a few assumptions. It assumes that your interfaces are all set for the same baud rate, of 9600bps (line 60), and also that if there are multiple interfaces, these have been set up for contiguous address codes starting at 0. Hopefully this program will get you off to a good start, in using your I/O interface. However just to provide a little further inspiration, I've also written a couple of other simple programs to show how easy it can be to achieve control effects.

If you build up the triac driver module and connect it to some coloured lamps, Fig.6 shows the listing for a very tiny program which will flash any of the lamps. It simply asks you to specify the interface address and the output line concerned, and will then flash the lamp (or lamps) controlled by that line, until you press any key.

The flashing rate is determined by the FOR-NEXT loop in line 100; to make it faster or slower as desired, simply alter the number of loops from the current figure of 500. A smaller figure will give faster flashing, and vice-versa. If you prefer to have all of the lamps flashing in sequence, to form a programmable 'light chaser', try the simple program in Fig.7. Again line 100 sets the flashing/chasing rate, and can be adjusted as before.

These are only gimmicky little programs, but they might inspire you to produce some more pretentious ones of your own. It really isn't hard, as you can see.

What next?

At first sight, the basic serial I/O interface and its driver/buffer modules might only seem capable of digital-type control — turning things either on or off, with no steps in between and no smooth or gradual adjustment. But there's no real reason why you can't use them for multi-level control too, with a bit of further elaboration. For example it would be quite feasible to use all four sections of the relay driver module together in a single circuit, to control the current level through a

Continued on page 110

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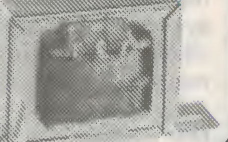

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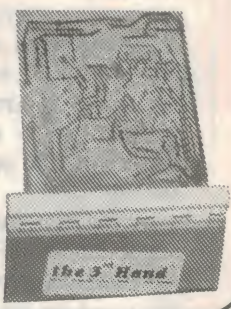

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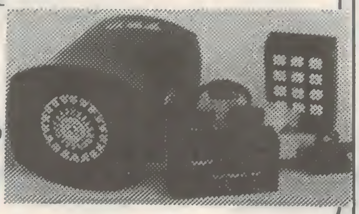

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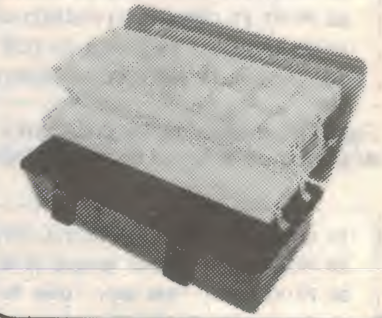

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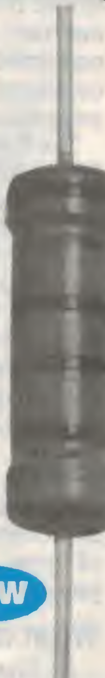

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3x15mm screw	25	HP0406	$1.30	$1.10
3x15mm screw	200	HP0407	$4.95	$3.95
3x20mm screw	25	HP0410	$1.40	$1.20
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Shake washer	25	HP0433	$1.40	$1.20
Shake washer	200	HP0434	$7.50	$5.95
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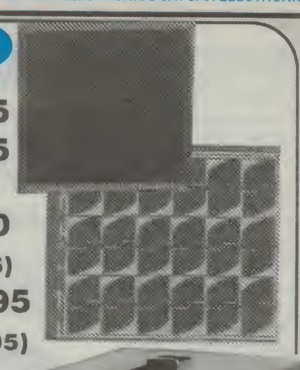
Nominal capacity 250mAH
Cat. SB-2475
$32.95

SOLAR PANELS

NEW



Due this month - NEW LOWER PRICES

12 volt	1 watt	Cat. ZM-9020	$24.95
12 volt	2 watt	Cat. ZM-9024	$42.95
	(1990 price was $79)		
12 volt	4 watt	Cat. ZM-9026	$75.00
	(1991 catalogue price was $89.95)		
12 volt	8 watt	Cat. ZM-9030	$119.95
	(1991 catalogue price was $169.95)		
0.45V	1A	Cat. ZM-9004	$6.50

JAYCAR 5MHz OSCILLOSCOPE

Features: • Bandwidth DC to 5MHz (.3dB) • Sensitivity 10mV/Div • Attenuator 1/1, 1/10, 1/100 • Sweep frequency 10Hz 100kHz 4 ranges • CRT 130mm round screen CRT

Cat QC-1910 **$399**

CRO PROBE TO SUIT

Probe is identical to our QC-1900 model 1x, 10x, but supplied with an adaptor. (BNC socket to two banana plugs.)

Cat QC-1912 **$45**

NEW

6-12V DC BUZZER BARGAIN

PC mount - pins are 15mm apart. Also includes mounting holes for panel mounting. Operates anywhere from 6 to 12 volts DC. Size 28mm diameter, 35mm mounting holes, 14mm high excluding pins. Cat. AB-3460

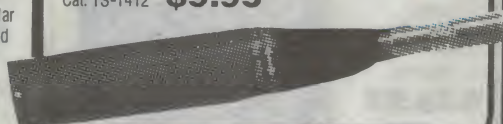
CRAZY PRICE
1-9 $2.95
10-99 $2.00
100 up $1.50

BUTANE MINI TOOL

At last a low cost quality, portable butane powered flame torch. Ideal for the hobbyist and professional. Adjustable flame, completely portable, up to 90 minutes use per fill, adjustable temperature control, mini size, uses standard butane gas lighter fuel. Ideal for shrinking heatshrink tubing.
Cat. TS-1410

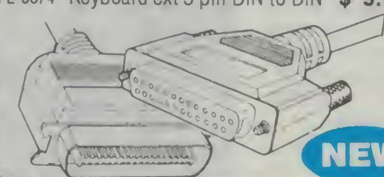
ONLY $12.95

SOLDERING OPTION
Cat. TS-1412 **$9.95**



NEW COMPUTER LEADS

Cat No	Description	Price
PL-0870	D9 female to D25 male, 2mt	$19.95
PL-0871	D9 male to D9 female, 2mt	$12.95
PL-0872	Centronics plug to centronics plug, 2mt	$19.95
PL-0873	Hi-density 15D male to female, 2mt	$14.95
PL-0874	Keyboard ext 5 pin DIN to DIN	$ 9.95



NEW

MINIATURE SPEAKERS

In keeping with Jaycar's philosophy of "Electronics for the hobbyist" we proudly announce two new miniature speakers. Up till now the smallest speaker available to the hobbyist has been the old 57mm size. We now have 40mm and 27mm Mylar cone 8Ω speakers. Their reproduction quality is excellent, and they are not expensive. 10+ LESS 10%

27mm Cat. AS-3002 **$2.50 ea**
40mm Cat. AS-3004 **$2.50 ea**

DIGITAL BLOOD PRESSURE METER

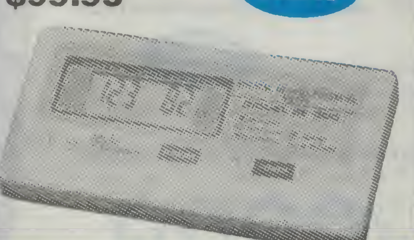
Oscillometric method

Keep an eye on your blood pressure at home with this easy to use digital electronic blood pressure meter. It uses the highly accurate oscillometric method to give systolic and diastolic pressure as well as pulse. Features include

• Easy operation
Designed for quick and simple one-touch operation
• High accuracy
High precision with oscillometric method and artifect reject algorithm
• Memory
Convenient memory function for previous reading

Supplied complete with comprehensive instructions, case and batteries (4-AA).
Cat. QM-7250
$99.95

NEW



HOBBY BOX

Quality ABS black plastic box. Ideal for use in cars as can be supplied with underdash mounting bracket. It may look familiar to many people as it's a radar detector enclosure. The front panel has a square hole and the rear panel has some odd shaped holes, but cables can be run through and in a car they won't be seen anyway. Dimensions 39(H) x 125(W) x 127(D)mm. Available two ways:

Box A includes top, bottom, front and rear panel, mounting bracket and two thumb screws.
Cat HB-5942 **$5.95**

Box B includes top, bottom, front and rear panels only.
Cat HB-5940 **$2.95**

NEW

BUY 10 OF ANY PRODUCT TAKE 10% OFF

PLUG PACK BARGAIN

240V mains to 15V AC 100mA. Supplied with 2 metre cable to a 2.1mm DC plug.
Cat. MP-3022

NORMAL PRICE is $9.95
STOCK UP NOW
ONLY $4.95

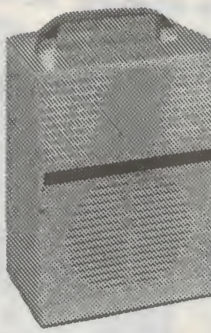
SAVE 50%

NEW

ELECTRONIC WATCHDOG

NEW

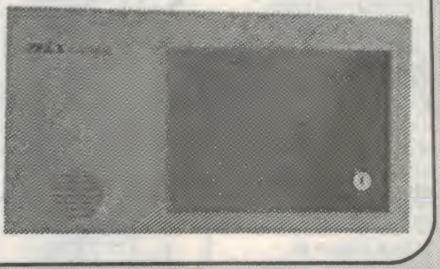
IF you are aged or live on your own, owning a dog can offer you wonderful peace of mind, especially at night from the risk of intruders. There are so many problems associated with owning a dog - feeding it, caring for it, walking it, vet bills, who looks after it on holidays etc.
This product can offer you peace of mind at night without all the fuss assocated with dog ownership.
The electronic watchdog incorporates a microwave motion sensor which activates when it detects movement and then it starts barking. It bark for 5 seconds each time it is triggered and barks continually if there is constant movement. The sound is very authentic and would easily scare the wits out of an intruder.
The unit is housd in a plastic box with a handle on the top. It operates form 240V through a plugpack (supplied) and has a volume control and a range of control.
Call into any store for a demo.
Cat LA-5280



$129.50

ECONOMY WIRELESS SECURITY SYSTEM

At last, you can now install your own wireless burglar alarm and it won't cost you and arm and a leg!
The new EG100 is made by Zeus, the same people who make our current wireless system. In fact, all the same wireless extras will work with this panel. The EG100 is a key operated single sector panel which accepts not only the wireless PIR's etc, but you can hard wire detectors as well. For example 2-wireless PIR's, 2 wireless door/window transmitters and a wired PIR will all work very happily on the one sector.
This is the lowest priced wireless panel we've seen that is TOP QUALITY. There are plenty of junky ones around that we just won't sell. After all - a burglar alarm that false triggers is no good to anyone!
FEATURES
• Low cost • DIY Installation • Accepts wireless and wired sensors • Tamper proof protected • LED indicators • Keyswitch arming with exit delay time • Instant alarm when sensors triggered • NC and NO relay output
SPECIFICATIONS
• Operates on 303-875MHz • System codes 4,096 • Transmitting range 50 metres (open space) • 30 second exit delay • instant entry delay
Accessories
• Back up battery 1.2A 12V Cat. SB-2480 $26.50 • Wireless passive infra red detector Cat. LA-5205 $129.95 • Door/window reed switch Cat. LA-5210 $69 • Siren 12V DC Cat. LA-5700 $28.50 • Strobe light Cat. LA-5300 $32.95 • Wired PIR's from $59.
Cat. LA-5202
Includes 240V power supply



NEW

$229

IBM PERSONAL COMPUTER UPGRADE GUIDE

By C Sandler and T Badgett
Packed with upgrade package hits, misses and preferences, you get expert advice on what to do with your PC. With all the information this handy text contains, you can even build your own custom design piece-by-piece!
This book is an invaluable resource on: • Upgrading advantages and disadvantages • Selecting hard disk drives and their components • Completing a computer "makeover" • Operating system upgrades • Printers and their options • Testing your upgrade system • Plus much more!
And it's all in a "straight-talking", conversational text that's easy to understand. So, whether you're a first-time computer buyer or a veteran computer technician, you'll find this one of the most helpful books around.
285 pages, softcover, 190 x 230mm
Cat. BS-0740

$39.95

NEW

UNDERSTANDING TELEPHONE ELECTRONICS

By J Fike & G Friend
Electronics is bringing lower costs and expanded capabilities to telephone communications. This book tells you how. Subjects covered include: dialling, ringing, transmission, signalling, switching, digital techniques, modems and the new cordless phone technology. It's all here in an easy-to-understand format, fully illustrated and ideal for self-paced learning.
284 pages, softcover 180 x 230mm
Cat. BS-0460

$34.95

NEW

ALARM CONTROL PANEL BOX

We have a quantity of super high quality alarm control boxes. They are painted cream and have various holes in the panel for LEDs, cam lock, etc. Some have the front panel printed, some don't, the holes vary and the size of the panels vary. The size of the sample is 330(H) x 230(W) x 85(D)mm, but some are slightly smaller than this.
This product is more suited to the personal shopper who can pick the one most suited, however, we will ship to mail order customers upon request. (Cam lock Cat SM-1029 $8.95. Locking arm may not be correct length in some cases.) Ideal for hobbyists and installers. Save a bundle.
Cat HB-5480

ONLY
$24.95 ea

2 PIN MAINS LEAD

This lead has a 2 pin Australian plug on one end and a 1.8m cable (black) to bare ends. Quality Burton brand, SAA approved. Limited quantity.
Cat. PS-4112

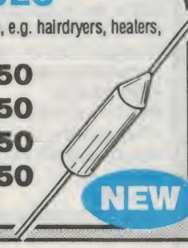
NEW

ONLY
$1.95

THERMAL FUSES

As used in many 240 volt applications, e.g. hairdryers, heaters, hot rollers, irons etc.

128°C	Cat. ST-3804	**$2.50**
152°C	Cat. ST-3808	**$2.50**
228°C	Cat. ST-3812	**$2.50**
240°C	Cat. ST-3815	**$2.50**

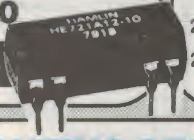


NEW

DIL REED RELAYS

5 volt	Cat. SY-4030	**$4.25**
12 volt	Cat. SY-4032	**$4.50**

LOWER PRICES



SPADE LUG MADNESS

Stock up now. This bargain won't last long. Standard QC - 6.3mm spade lugs.
50 MALE, 50 FEMALE, 50 PLASTIC COVERS
Cat. PT-4510 **$8.95**

4-CHANNEL LIGHTING DESK KIT

Refer Silicon Chip June 1991
This 4-channel lighting desk is intended for theatre, disco and music group applications. It has heavy duty circuitry and is able to cope with spotlights rated up to 1000 watts or more.
Operating features
• Four channels • 60mm slider pots • Click action flash switches with integral LEDs
• Separate dimming for each channel • Master dimmer control • Flash on each channel
• Master dimmer for flash • 4-channel chaser • Adjustable chaser rate • Single step for chaser • Chaser on and off
• Flash switch LEDs mimic lamp display
The Jaycar kit includes pre punched and silk screen case, original C and K switches, original slider pots (Jaycar supplied the samples to Silicon Chip) and all specified components. Beware of kits with non original parts.
Cat. KC-5096

NEW

$329

JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS

SUPER BULLET TWEETER

Another surplus bargain. These are a piezo Hi Fi tweeter, but in a strange shape. They were used in a Kangaroo scaring device, but the manufacturers had a model change and these became surplus. The specifications are similar to our economy piezo tweeter (Cat. CT-1905), but the shape is rather different.

NEW

SPECIFICATIONS
Frequency Response 800 - 40k
Peak Power 75 watts Intermittent
Use with or without crossovers. Size 50mm diameter, 60mm mounting holes, length 75mm including bullet.
Cat. CT-1906

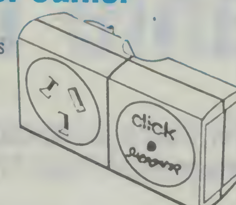
ONLY $2.95
10+ less 10%
100+ $2.00 ea

BUILD A ROW OF DIRECTIONAL TWEETERS

CLICK SURGEBUSTERS

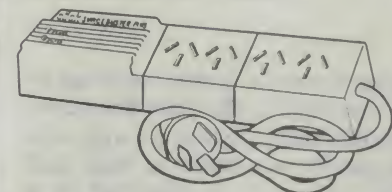
NEW

Surgebuster Junior



Safety assured surge protected power outlet plus $5,000 FREE Insurance against damaging voltage spikes and power surges.
Cat. MS-4010
$29.95

Surgebuster Plus



High level protection against damaging power surges plus provides line noise filtering to minimise electrical interference. 4 protected outlets and overload cut-out. Recommended for PC's, Hi Fi and other valuable electronic equipment.
Plus $5,000 FREE Insurance
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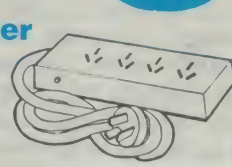
NEW

4 Way Power Board



with overload protection
Cat. MS-4040
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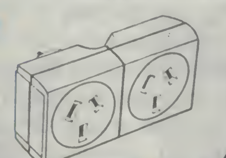
Space-saver Double Adaptors



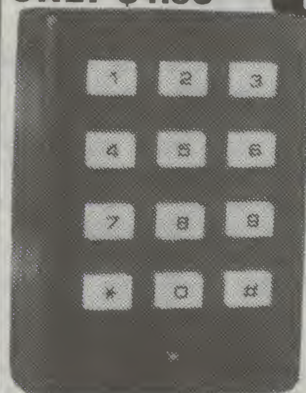
Cat. PP-4035
$4.25

FAKE CAR ALARM

Save your car for less than $5!
Were selling for $19.95!

It's a black box with 12 digits on the top and a flashing LED. It looks very similar to the controller on a very expensive car alarm (the one that guarantees your car won't be stolen.)
So, with this sitting on your dash, would be thieves will think you have a high quality alarm, and move on.
Can be used on its own, or to complement any existing alarm system.
Use on cars, around the home, on boats, etc. Easy to install, size 70 x 50mm, sticky tape already supplied on back. Includes alarm sticker. Requires 2 x AAA batteries (not included) Cat. SB-2375 $1.95 for two.
Cat. LA-5105
ONLY $4.95

SAVE 75% over 1988 price



Wholesale enquiries contact Bruce Routley (02) 747 2022

WIRE ON SMALL REELS

NEW

You know the scenario! You buy a few metres of cable and by the time you get round to using it, it's all messed up and it takes you twice as long because half the time is spent on untangling it. It's not only frustrating - it can damage the cable. Jaycar has now solved your problem! Our most popular cables are on small reels.

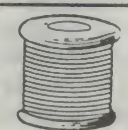
LIGHT DUTY SPEAKER CABLE

14/0.14mm Cat. WB-1703 30 metre roll NORMAL PRICE 30¢ metre
$7.50 SAVE $1.50

HEAVY DUTY SPEAKER CABLE

24/0.20mm Cat. WB-1709 30 metre roll NORMAL PRICE 55¢ metre
$13.50 SAVE $3.00

75Ω 3C2V TV COAX



Cat. WB-1999 30 metre roll
NORMAL PRICE 80¢ metre
$17.95
SAVE $6.05

TURN YOUR SURPLUS STOCK INTO CASH!!

Jaycar will purchase your surplus stocks of components and equipment. We are continually on the lookout for sources of prime quality merchandise.

CALL MARK HARRIS OR BRUCE ROUTLEY NOW ON (02) 747 2022

NEW MULTIMETER KIT

An excellent way to learn about electronics and the result will be a quality analogue multimeter you can use for years. Ideal for the educational area, schools, etc.
The unit is supplied partially assembled, there is however, some soldering required. Kit includes everything to get the unit operational including leads and probes and batteries.

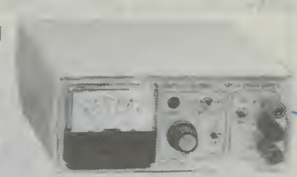
SPECIFICATIONS
- 20,000 ohm/volt
- Continuity buzzer
- 1.5V battery check
- dB measurements
- Diode & fuse protected
- 19 ranges

Cat. KC-5058 **NEW**
$37.95

NEW KIT

LOW COST 18V 1A BENCHTOP SUPPLY KIT

Ref: EA August 1991
This economy priced power supply features: • variable output voltage from 2.5 to 18V • switchable current limiting • both voltage and current metering. The Jaycar kit includes PCB, all specified components, Scotchcal panel and meter scale.
Cat. KA-1736



$79.95

Jaycar ELECTRONICS

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Construction Project:

Programmable Trip Meter

Our digital trip meter can tell you how many kilometres remain for a journey, or how far you've already travelled. It uses the same sensor described for our popular speedo project, or you can use our new Hall effect sensor.

by JEFF MONEGAL

Most cars have a mechanical trip meter as part of the speedo. But these can only indicate how far you've travelled, rather than how many kilometres remain for the journey. The trip meter described in this article not only gives an easy to read LED display, but allows a number to be entered, such as the distance to the destination. By selecting 'count down', the display will decrement as the vehicle travels, indicating the remaining distance.

Naturally it will also count *up*, giving an excellent addition to the digital speedo described in January 1991.

In fact, this project can be operated from the same sensor used with the speedo, so if you have built the speedo, you can very easily add the trip meter. Or maybe you have fitted the intelligent blinker unit described in February 1991. This project also uses the same sensor, and we have tested operation of all three projects running from the one sensor. By the way, an alternative to the coil and magnet sensor has now been developed, featuring a Hall effect device. It also uses magnets attached to the drive shaft, but the distance between the magnets and the sensor can be up to 10mm compared to the 5mm maximum for the coil-magnet sensor. As well, it is lighter, smaller and easier to make and fit. The new sensor is described in a separate article.

To use the trip meter, you enter the distance to the next destination with the keypad, then press either the '*' or '#' keys. That's it! The meter will then count the kilometres, either up or down as selected. The count down action is particularly useful, especially on long trips as everyone in the car can read the display, eliminating the eternal question 'How far before we get there?'

The unit fits into a jiffy box, and any three-digit number can be entered with no more than three key presses. A further feature is that the display will automatically dim when the headlights are turned on, giving an appropriate intensity for both day and night conditions.

How it works

The circuit at first seems rather complex, but is simple enough when broken into sections. The first section is the sensor amplifier, consisting of Q1 and associated components. This section is for the coil and magnet type sensor as described for the car speedo and blinker light projects. The Hall effect sensor connects directly to the input of IC1c. Because the coil is a short circuit to DC, under no-signal conditions D14 is held forward biased, holding Q1 off. This gives a high at the collector of Q1, and a low at the output of IC1c.

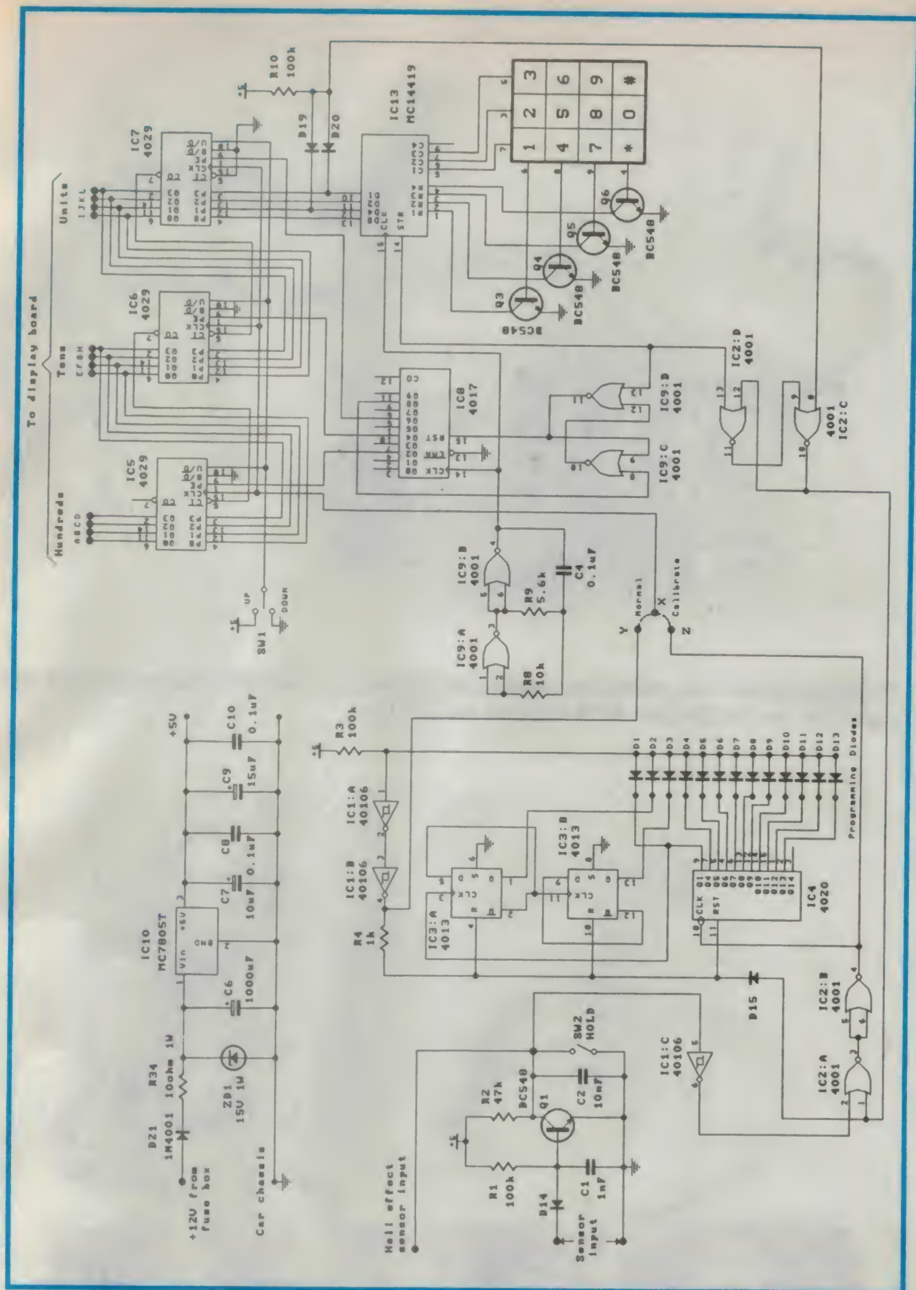
When the vehicle is moving, the magnets attached to the drive shaft induce a voltage in the coil, causing D14 to become alternately forward and reverse biased. As a result, pulses will appear at the collector of Q1, inverted by IC1c. These pulses are passed to the clock input of counter IC4, via the OR gate of IC2a and IC2b.

To disable the input, SW2 is connected across Q1. This prevents further counting when the switch is closed. This function is included to stop the trip meter counting, perhaps during an unplanned deviation on a journey.

The counter of IC4 is a binary type with 14 stages, but lacks outputs for the divide by 4 and divide by 8 sections. To derive these, IC3 is wired as a 2-bit counter, driven by the Q1 output of IC4. The Q output of IC3a (pin 1) produces the divide by 4 output and IC3b gives the divide by 8 output. The final result is a counter able to give the required binary representation of any decimal number from 0 to 8191.

The diode AND gate consisting of D1 to D13 is used to program the circuit so that a single pulse is produced per kilometre. As described further on, the correct combination of diodes is selected by first determining the number of pulses produced per kilometre. This will vary between vehicles, as it depends on gearing, tyre size and so on.

Then, by fitting those diodes whose binary weightings total the number of pulses per kilometre, one pulse output will occur per kilometre. The resolution



Circuit Diagram 1: The sensor provides clock pulses to a counter, programmed with diodes D1 to D13 to give one pulse per kilometre. This pulse then clocks the display counters IC5 to IC7. The keypad is interfaced with IC13 and IC8, and IC9a - b form an oscillator to allow numerical entry from the keypad.

is high, as there will be several thousand pulses generated by the sensor per kilometre. In the prototype, 4078 pulses per kilometre were registered, giving 4.78 pulses per metre or a resolution of 0.209 metres per pulse.

When the programmed count is reached, R3 pulls the output of the AND gate high, with buffering provided by IC1a and b. This pulse then clocks the display counters, IC5 to IC7. The pulse is also fed back via R4 to reset the distance counters of IC3 and 4.

Switch SW1 is used to select either count-up or count-down of the display counters. The flipflop made of IC2c and IC2d is used to inhibit counting when a number is being entered from the keypad. Whenever a numeric key is pressed, the strobe pulse from pin 14 of the keyboard encoder IC13 sets the flipflop so that pin 10 (IC2c) is high. This holds the output of IC2b high. The circuit interfacing the keypad is around IC8, IC9 and IC13 and the display PCB is driven by the counters of IC5 to IC7. Notice that the output lines of the 'units' counter (IC7) go to the preset inputs of the 'tens' counter (IC6), whose outputs go to the preset inputs of the 'hundreds' counter (IC5). The data from IC13 is applied to the preset inputs of the units counter.

When any numeric key is pressed, a positive-going pulse is produced by IC13 at pin 14 (strobe) after a short debounce period of 80 clock cycles (from an internal clock within IC13). This pulse resets the flipflop of IC9c and IC9d, so that pin 11 goes low, allowing the counter of IC8 to count.

Clock pulses from the oscillator formed by IC9a-b clock IC8 (a Johnson counter), sending its outputs high one after the other. This IC has three of its outputs connected to the parallel load inputs (pin 1) of the three display counters and pin 4 goes high first, followed by pin 10, then pin 5 and finally pin 9.

The sequence starts when the strobe pulse from IC13 occurs, and the data from IC6 (tens counter) is first transferred to the hundreds counter IC5. After two more clock pulses, the data from the units counter is transferred to the tens counter and a further two clock pulses later, the data from IC13 (from the keypad) is loaded into the units counter. After another two clock pulses, pin 9 of IC8 goes high, setting pin 11 (IC9d) back to a high, which holds IC8 in the reset condition. Thus each digit is shifted to the left of the display whenever a numeric key is pressed, allowing any three-digit value to be entered with three key presses.

When the required numerical value has been entered, the sequence is stopped by pressing either the '#' or '*' key. Either of these keys will give an output code from IC13 that produces a logic 1 on both pin 12 (output D4) and pin 10 (output D1). This reverse biases diodes D19 and D20, allowing resistor R10 to pull the input to IC2c (pin 8) high — resetting its output to a low. This enables the OR gate of IC2a and b, allowing distance pulses to be applied to the counters IC3 and 4. Note that during normal operation a link is connected between points X and Y, giving one pulse per kilometre to the display counters.

This link is provided to allow the unit to be calibrated. By linking points X and Z (instead of X and Y), the display is made to count all pulses from the sensor, giving a display of the total number of pulses produced per kilometre. Transistors Q3 to Q6 are part of the keyboard encoder circuit, along with IC13. For this IC to recognize a key press, a column input and a row input must be taken low.

However, a keypad that does this is fairly expensive and Q3 to Q6, in combination with a basic matrixed keypad

overcome this problem. All column and row inputs on IC13 have internal pull-up resistors, allowing this circuit to be used.

When a key is pressed it connects the base of the transistor in that row to a column input of IC13. This supplies base current to the transistor via the internal pull-up resistor, turning that transistor on.

As a result, the column input connected to the transistor is pulled low. The row input is also pulled low, via the base-emitter junction of the transistor (actually pulled down to 0.6V), giving the required input conditions to the IC. The remaining components in the circuit are those associated with the power supply. Diode D21 protects the circuit against accidental polarity reversal, the zener diode and R34 limit the input voltage to IC10 and the capacitors provide the necessary filtering. The 5V output is supplied by IC10.

The display section

The display board is a separate PCB and includes the the 7-segment decoder/driver ICs, the three common-cathode displays and a dimming circuit around IC1f.

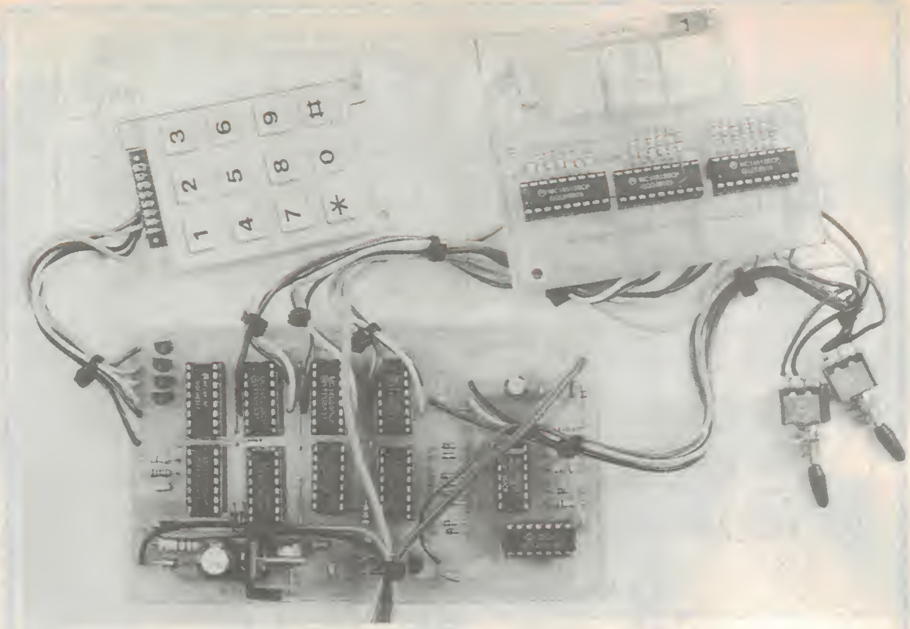
This circuit is similar to that used in the digital speedo, in which an oscillator around IC1f is used to modulate the display intensity through pin 4 of IC10 to IC12.

When the car lights are off, the timing components for the oscillator are R6, R7 and C3, giving an output that is high some 56 times longer than its low time — due to the ratio of R6 and R7. Thus the displays are virtually always on. But when 12V is applied to D16, the output waveform has equal high and low times as R5 is effectively placed in parallel with R6, giving reduced brightness of the display.

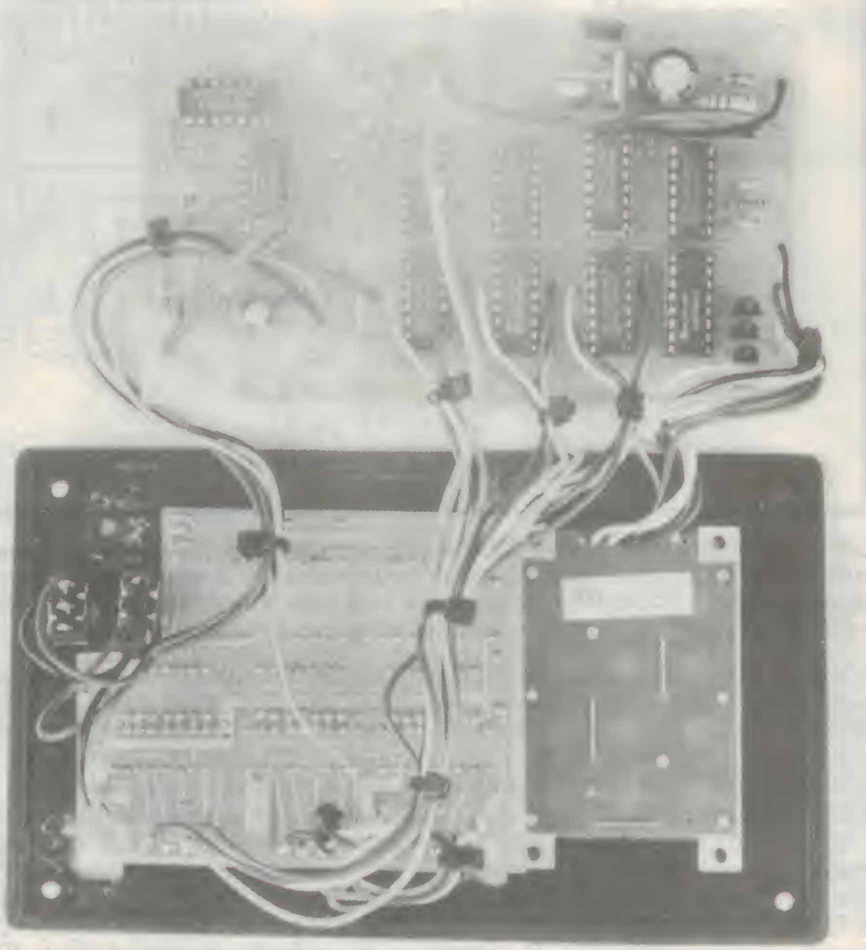
Leading-zero blanking is provided by the connection between the RBO terminal of IC10 (pin 10) and the RBI terminal of IC11 (pin 8). As the circuit must be powered continuously to retain the kilometre count, Q2 is used to switch the displays off when the ignition is off. This transistor is held on while the ignition switch supplies 12V to R33, giving a path to earth for the displays, allowing them to light.

Construction

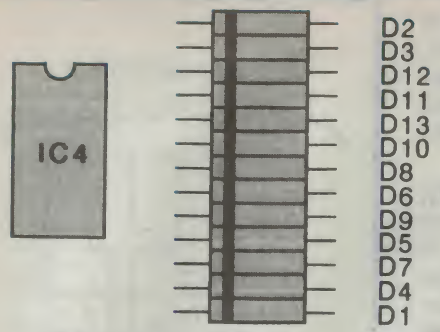
The circuit is constructed on two separate boards, which then connect together with wire leads. Start with the display PCB, first inspecting the board for any manufacturing faults. Then fit



This shot shows the complete assembly of the tripmeter. The transistor and the capacitor on the display PCB need to be laid flat.



To fit the keypad, cut a rectangular section out of the lid (55 x 44mm). If necessary, a dab of silicone glue can be used to hold the keypad in place. We used plastic PCB supports, glued to the lid to hold the display board in place. The main PCB can sit inside the case



Diode number	Binary value
D1	1
D2	2
D3	4
D4	8
D5	16
D6	32
D7	64
D8	128
D9	256
D10	512
D11	1024
D12	2048
D13	4096

Example: If vehicle generates 3077 pulses per kilometre, from table select:

D1	1
D3	4
D11	1024
D12	2048
Total	3077

Fig.1: Use this table and the example to determine the diodes needed to give one pulse per kilometre.

and solder the three links followed by the passive components. Note that the electrolytic capacitor C5 needs to lay flat on the PCB. Next fit the three displays and transistor Q2, then lay the transistor flat on the PCB (metal surface face down).

We recommend sockets for the ICs, although you could solder them directly if you wish, as done in the prototype.

The main PCB has a number of closely spaced tracks, and again a visual inspection for manufacturing errors is suggested before starting construction. A fine-tipped soldering iron is essential, along with a steady hand — perhaps viewing everything through a magnifier.

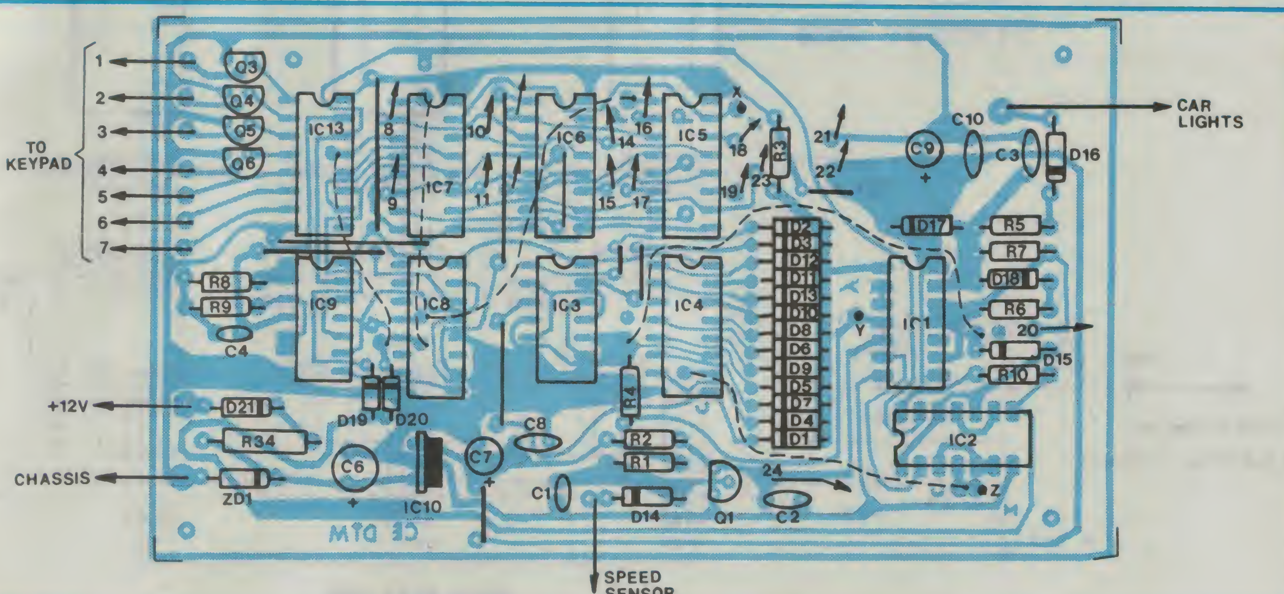
Because the PCB is single-sided there are a number of links required, on both sides of the board. There are 11 links on the component side of the PCB, with one placed under IC5 and another under IC6, and all of these links should be fitted first.

Next fit and solder the resistors and capacitors, taking care with the polarity of the electrolytic capacitors. Then solder the transistors, the voltage regulator and the zener diode in place. Fit a small heatsink to the voltage regulator. Don't fit diodes D1 to D13 yet, but the remaining diodes can be installed. Again IC sockets are recommended, and these can now be soldered in place. The five links on the track side of the board should be connected, using insulated hook-up wire for the links. As well, connect a temporary link between points X and Z.

The two PCBs are connected with hook-up wire and these are soldered on the *track* side of the display PCB, and via the component side of the main PCB. There are 15 wires between the boards, numbered from 8 to 22 on the layout diagram. Use insulated and differently coloured hook-up wires of around 140mm in length.

The keypad is connected with seven wires, numbered 1 to 7 on the layout diagram. Refer to the diagram of the keypad, which is drawn looking at the key side of the keypad. Note that connection points 1, 2 and 10 are not used on the keypad. Use 80mm lengths of differently coloured hook-up wire. Also connect the two switches as shown in the layout diagram. The ground and +5V wires come from the display PCB and the other two (23 and 24) come from the main PCB. Those from the display PCB should be around 50mm long, while the wires from the main PCB approximately 150mm to 200mm long.

There are five wires that connect the



The layout of the main PCB. The links fitted to the track side of the board are shown dotted. Remember to fit the links on the component side of the board first, as two of these are under ICs. A small heatsink is required for the voltage regulator.

unit to the car wiring and the sensor. These could be terminated in a connecting strip, to allowing the external wiring to be connected without soldering. You'll initially need the two 12V wires and the ground wire for testing purposes.

Bench testing

To test the unit, connect a 12V DC supply between the two 12V inputs and ground. When power is applied, the display will be random, and some digits may not even light due to the leading zero blanking. The current consumption will depend on the numerical display, but should be around 200mA for a display of '888'. Pressing any numeric key should cause that value to be indicated by the units display, and subsequent key presses should cause each digit to shift left. If all is working so far, connect an audio signal generator or pulse generator to the sensor input. Make sure the HOLD switch is in the off position for this test. The maximum input frequency is around 500Hz and a test signal of 50Hz square wave, 500mV p-p (or greater) should be selected.

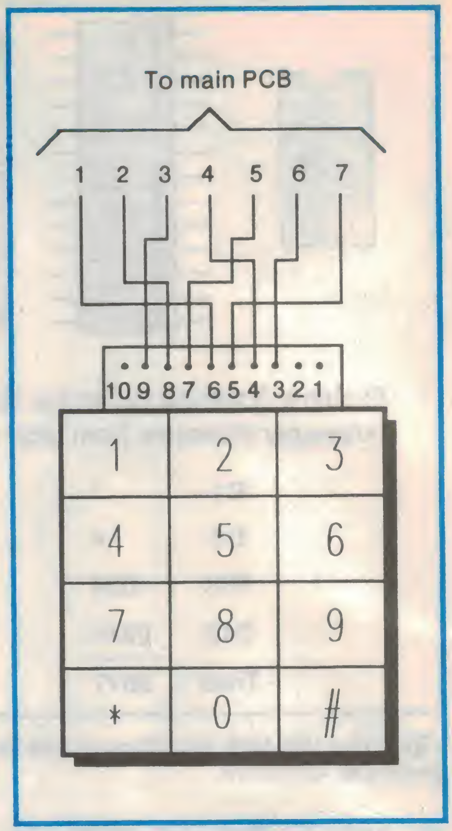
Set the display to 0 (the units digit only should be lit) then press either the '*' or '#' key to store the number. The unit should now either count up or down, depending on the setting of SW1. Check that the direction of the count changes with the operation of SW1, and also confirm that the 'hold' switch SW2 freezes the display.

If the unit is not working correctly, check first for faulty soldering and components in the wrong position or installed with incorrect polarity. Also confirm that the supply voltages are correct and present at the power pins of all the ICs. Check particularly that there is an output at pin 6 of IC1c, as this confirms that the signal input has the correct level. If all else fails, CTOAN Electronics offer a faultfinding service, as described at the end of the article.

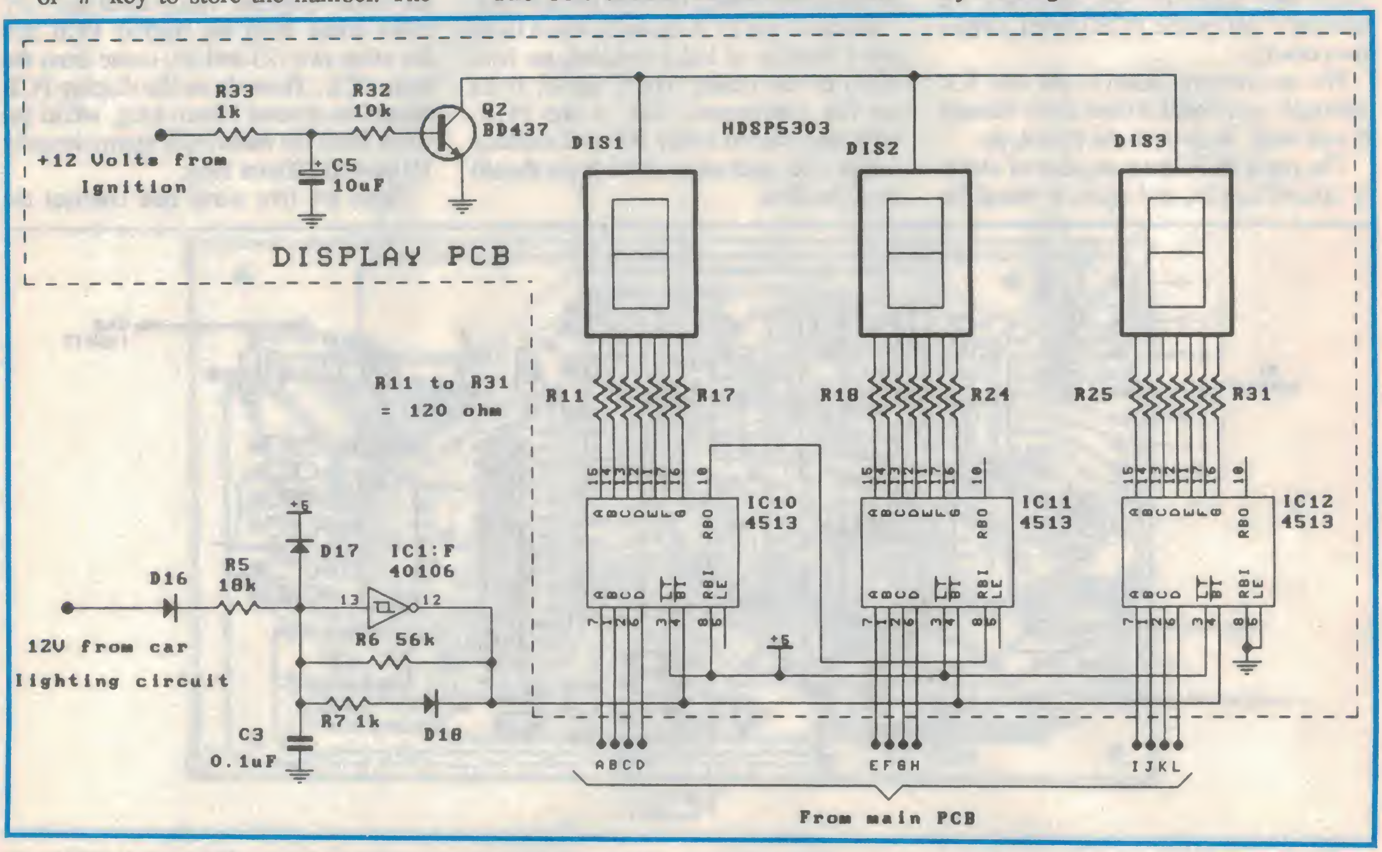
Sensor construction

The sensor is the same as that used in our previous projects and the coil requires approximately 600 turns of 0.2mm (32 B&S) enamelled winding wire, using a 3mm (1/4") steel bolt as a core. Make a bobbin by fitting two nylon or plastic washers of around 30mm diameter over the bolt, spaced apart by approximately 10mm. Wrap insulation tape over the section of the bolt between the washers before winding the coil.

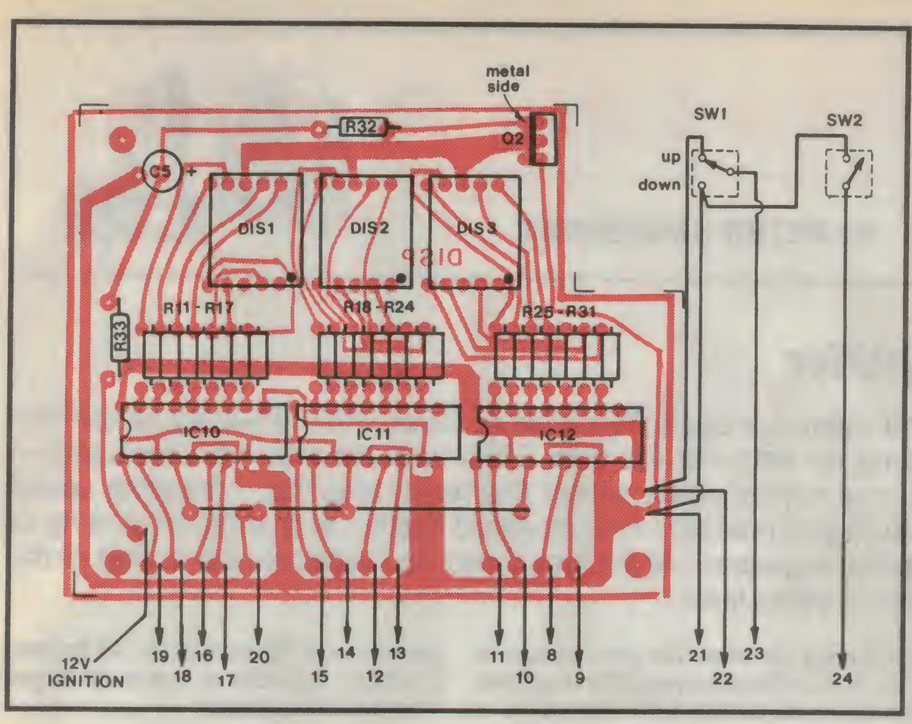
The bolt should be at least 25mm



This diagram shows the wiring from the keypad to the main PCB. The wire numbers relate to those shown on the layout diagram for the main PCB.



Circuit Diagram 2: The display section has three common-cathode displays driven by IC10 to 12. The displays are turned off by Q2 when the ignition is switched off, and the oscillator around IC1f is used to control the brightness of the display.



The layout of the display PCB, which also shows the wiring to the two switches. This board connects to the main PCB with wires numbered from 8 to 22. Wires 23 and 24 from the switches also connect to the main PCB.

long, as it is also used to attach the coil to the vehicle. Drill an exit hole in one washer for the wire, then with the wire passed through the hole, wind the coil onto the bobbin. Keep the layers as neat and even as possible, to ensure that all 600 turns fit on the bobbin.

Cover the winding with tape, then terminate the ends with insulated wire leads soldered to the winding wire. Fit a nut onto the bolt to hold the bobbin together, then pot the coil with an epoxy glue to make it waterproof and to protect it from damage.

When the coil is connected to the trip meter, some response should occur if a magnet is passed to and fro over the bolt head. The coil should be secured to a bracket bolted on the underside of the vehicle, arranged so there is a gap of around 1 to 5mm between the magnets and the bolt head. The magnets are attached to the drive shaft with double-sided tape, then securely held with non-magnetic wire wound over the magnets. Use two magnets for rear drive vehicles, and four for front-wheel drive vehicles.

The coil can be earthed on one side to the vehicle chassis, or connected via two wires to the trip meter. Make sure the wire(s) are positioned for maximum protection. For further details, refer to page 109 in either the January 1991 or February editions of *EA*.

Programming

Assuming the sensor is installed and the trip meter operational, the next step is to determine the number of pulses produced per kilometre. At this stage, diodes D1 to D13 are not fitted and a temporary link is required between points X and Z on the main PCB. Naturally, the meter needs to be connected to the vehicle's 12V supply system and the sensor connected to the trip meter.

The idea is to drive the car for a predetermined distance and to use the display to indicate the number of pulses developed over this distance. We used a distance of 100 metres, measured between two markers on the road.

Start by setting the display to zero and the hold switch to HOLD. Then drive the vehicle at around 35kph, commencing some distance before the first marker on the road.

You will need an assistant to turn the hold switch (SW2) off as soon as the first marker is reached. When the end marker is reached, return the switch to the hold position and note the number of pulses registered by the display. Repeat this exercise several times, to get an accurate count.

You could also try driving for 200 metres and so on, although the maximum count the display can show is 999. However the assistant could note how many times the display resets to zero, for counts over 999.

Then it's back to the work bench to fit the diodes. You will need to know the number of pulses per *kilometre*, so if the test run was 100 metres, multiply the obtained count by 10. The table and example in Fig.1 show the binary value of

Continued on page 107

PARTS LIST

Resistors

All 1/4W, 5% unless otherwise stated:

R1,3,10	100k
R2	47k
R4,7,33	1k
R5	18k
R6	56k
R8,32	10k
R9	5.6k
R11-R31	120 ohm
R34	10 ohm, 1W

Capacitors

C1	1nF ceramic or polyester
C2	10nF ceramic or polyester
C3,4,8,10	0.1uF monolithic
C5,7	10uF 16V electrolytic
C6	1000uF 16V electrolytic
C9	15uF 16V electrolytic

Semiconductors

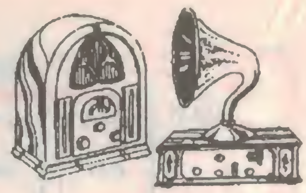
D1-20	1N914 signal diode
D21	1N4001 1A diode
ZD1	15V 1W zener diode
Q1,3-6	BC548 NPN transistor
Q2	BD437 NPN transistor
IC1	40106 (or 4584 or 74C14) Schmitt inverter
IC2,9	4001 quad NOR gate
IC3	4013 dual D flipflop
IC4	4020 binary counter
IC5-7	4029 up/down counter
IC8	4017 decade counter
IC10-12	4513 display drivers
IC13	4419 keyboard encoder
IC14	7805 5V regulator
Displays	HDSP5303 common-cathode displays

Miscellaneous

PCB 130mm x 75mm coded OE DTM; PCB 85mm x 70mm coded DISP; 12 key, matrixed keypad; two SPDT miniature toggle switches, plastic case 50 x 70 x 155mm; speed sensor coil (see text) and two bar magnets; red perspex; three PCB standoffs; hook up wire, solder, nuts, bolts, etc.

Vintage Radio

by PETER LANKSHEAR



The Loftin-White amplifier

In the 1929 edition of his standard reference book *Principles of Radio*, Keith Henney stated that spending time and effort on making an amplifier flat from 50Hz to 5kHz was not warranted — because a 10dB drop at the ends was not too easily noted! The reality was that increasing use of the moving coil speaker was encouraging research into improved fidelity, and at the beginning of 1930 the unique Loftin-White amplifier appeared. At the time it had an impact similar to that of the Williamson design which appeared 15 years later.

By 1930, wide range amplifiers were being developed for the movies and broadcasting, but for private users these were generally either unavailable or too expensive. The output pentode had been adopted to a limited extent in Europe, but America still relied on insensitive output triodes. A typical driver stage using the ubiquitous 27 triode produced a gain of about 25, but the gain in a resistance-coupled stage was only six. And things were not significantly better with the comparable Philips E415. Little wonder, then, that transformer coupling was practically universal.

Although transformer coupling had a lot of merit, there were also serious limitations. Inadequate inductance affected low frequency performance, and resonances, capacitance and leakage inductance restricted the high frequency response. Efforts to improve one end of the spectrum were traded off by a deterioration at the other. The performance of the Kolster-Brandes amplifier described in *EA* for September 1989 was typical.

To achieve high resistance-coupled gain, some work had been done with the first screen-grid valves, the UX222 and S625, but results were indifferent. The introduction early in 1929 of two improved valves, the mains powered UY224 screen-grid and UX245 output triode promised better amplifiers. One line of research was into resistance coupling the 224, using the outer grid as a control grid and the inner grid as a space charge electrode.

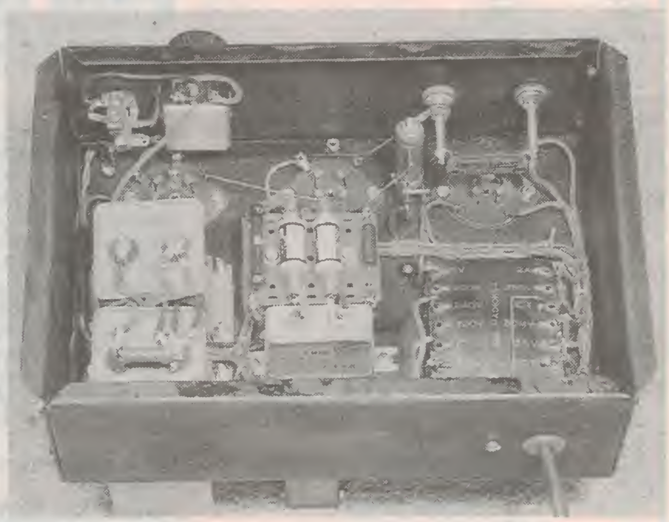
There was, at the time, a common misconception about the practicality of resistance coupling of output stages. It was held that when a Class A valve was driven to full output, grid current would cause grid blocking, from a build up of negative charges on the coupling capacitor. In reality, once valves of adequate power capability such as the 45 became available, distortion at maximum output was the limiting factor.

Direct coupling

One solution to the supposed 'problem' of grid blocking was to eliminate the coupling capacitor by direct coupling. It had been tried, but was impractical as the smallest drift anywhere in the chain upset the operation of the entire amplifier.

In today's solid state technology, direct coupling of audio power amplifiers is universal, but is very dependent on negative feedback for stabilisation. In 1929 the only type of feedback recognised was positive — good for oscillators, but to be avoided in amplifiers.

Edwin H. Loftin, with a background of naval electronics, and S. Young White, a General Electric research worker, had joined forces in 1924 to form the Loftin-



A surviving Loftin-White amplifier, very similar to the Electrad version of Fig.3. The wiring techniques are typical of 1930.

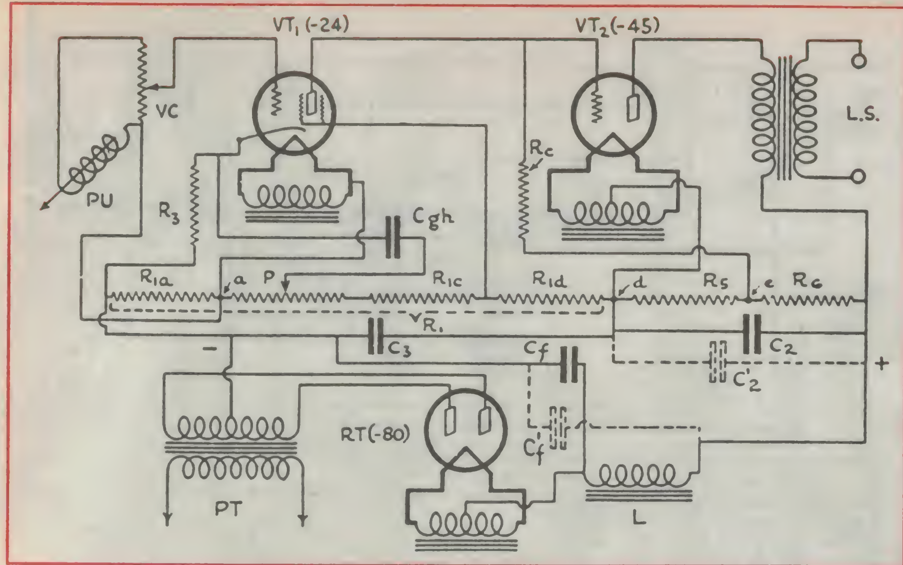


Fig.1: The original Loftin-White amplifier. All capacitors are 1.0uF.

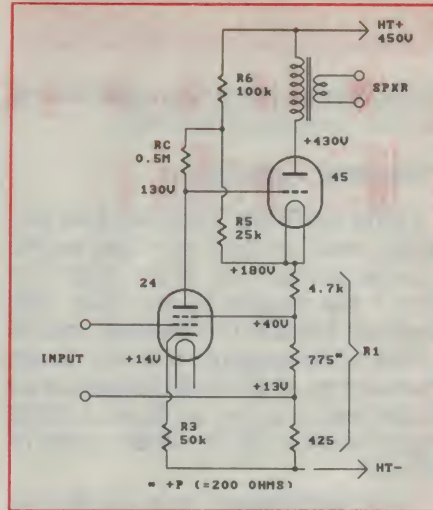


Fig.2: The DC configuration and voltage distribution in the original Loftin-White circuit. It was very stable.

White Laboratory. Some time later, they turned their attention to problems of audio amplification.

Loftin and White reasoned that a single direct-coupled 24 tetrode would have sufficient gain to drive a 45 triode, provided that there was some way of stabilising the combination. The outcome was a very successful but simple direct resistance-coupled two stage amplifier. With no interstage transformers, the Loftin-White amplifier had, for its time, a wide frequency response, and was both compact and inexpensive.

Very stable

The configuration was ingenious and is a very early example of the use of DC negative feedback. Fig.1 shows the original schematic, while Fig.2 analyses its DC operation.

HT is fed conventionally through the primary of the output transformer to the anode of the 45 output triode. A voltage divider connects its filament to HT negative. The grid of the 45 is connected directly to the anode of the 24 and a 0.5 megohm load resistor. Screen and control grid are fed from taps on the voltage divider and a cathode resistor provides automatic bias for the 24.

This arrangement produces very stable operation. A current increase through the 45 causes a rise in the screen and control grid voltage of the 24, increasing the current in R1. This in turn lowers the grid voltage of the 45, opposing the current rise. Alternatively, a reduction in the 45 anode current is countered by a lowering of the 24 control voltages.

The operational parameters are set by the screen and grid voltages of the 24, and are virtually independent of the characteristics of the 45. To check this aspect, I tried in turn, a standard and a low emission 45 and then a type 2A3, a much higher performance valve. Despite the wide differences in characteristics, there was a variation of only a few milliamperes in the anode currents of the three valves.

Massive HT voltage

Full output with low distortion was obtained with less than half a volt of input. There was a price to pay, though. Total power consumption was 35 watts to produce little more than one watt of audio power, and a power supply delivering 450 volts was necessary!

A novel method of hum reduction was used. Electrolytic capacitors were not commonly available before 1931, and high capacitance 500 volt paper capacitors were very expensive. By injecting into the cathode of the 24 a correctly proportioned bucking voltage from a variable resistor in the voltage divider chain, it was possible to cancel hum in the HT supply. As a result, filter capacitors of only 1.0uF were sufficient.

The frequency response was claimed to be practically flat from 35Hz to 6kHz, but this did not include the output transformer — which in most cases would have caused some degradation. Even so, the performance of the Loftin-White am-

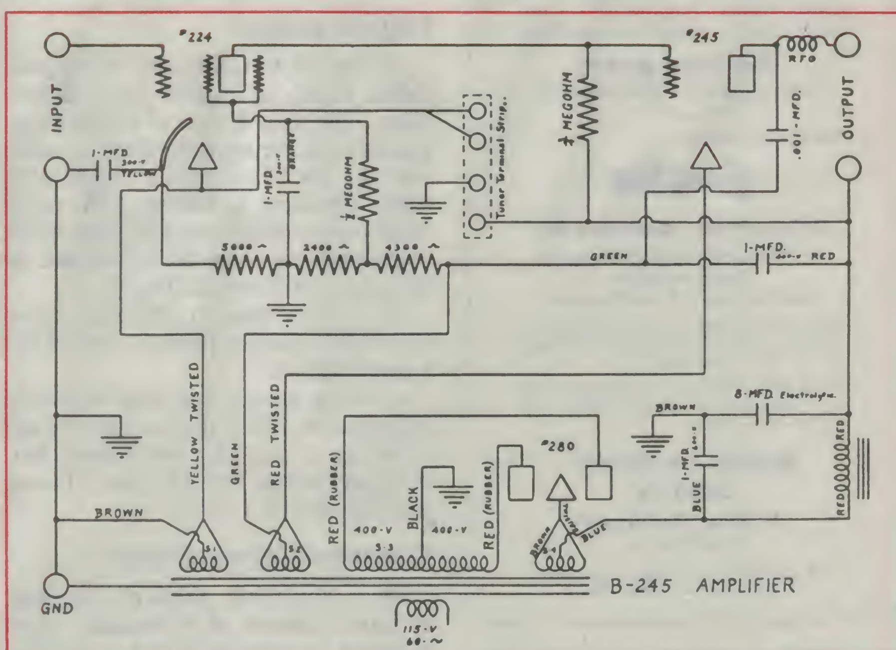


Fig.3: Electrad's later 1931 version of the Loftin-White circuit, with improved filtering and an earthed input terminal.

plifier was a considerable improvement on other contemporary designs.

Detector operation

Loftin and White stated that their amplifier could be used as a high quality receiver detector and audio system. At first, I was puzzled by this claim. AM detectors function by distorting, and the Loftin-White amplifier was very linear. Furthermore, if the 24 did function as an anode bend detector, would not a strong signal have cut off the anode current of the 45?

Some experiments soon proved that the amplifier does indeed constitute a good detector/amplifier combination. There is no demodulation below an input of about one third of a volt, the level at which audio overload commences, but RF signals above this level are demodulated with low distortion. The DC stabilisation holds the anode current of the 45 constant, the only variations occurring in the 24's screen current. With a reasonable amount of RF amplification, the Loftin-White amplifier could certainly be the basis of an effective radio receiver.

Higher power

In June 1930, Loftin and White published details of higher powered versions. One used a pair of 45 valves in parallel, but the most startling variation was the use of a 50 watt transmitting valve, operating at a lethal 1250 volts! More conventional was a 10 watt model using push-pull type 50 valves and an HT supply of 550 volts (Fig.4).

An improvement in efficiency came from using speaker fields as part of the voltage divider.

A battery version was more academic than realistic. Using the then-new 32 and 31 valves, it called for two filament batteries and no less than 270 volts HT — to produce about 0.3 watts!

Commercial versions

The Loftin-White amplifier was built by large numbers of enthusiastic home builders, and many firms, including some in Australasia, sold kitsets. There were, however, two weaknesses in the original design. The hum bucking control was critical in its setting, which changed with valve ageing, creating problems for non-technical users. Another problem was caused by there being no input terminal connected directly to earth — both sides were 'floating'.

Electrad, a resistor manufacturing firm, made suitable modifications to eliminate these problems and marketed a range of Loftin-White amplifiers, especially for PA work (Fig.3). But the major commercial application came as a result of a market trend in receivers.

Coincident with the development of the Loftin-White amplifier, market depression led to cost saving efforts to get away from the big console receivers of the period. The answer was the 'midget' receiver — later to be known as the 'mantle' radio — and some manufacturers used the Loftin-White circuit as the basis of their design. It was compact, did not need expensive interstage transformers and performed well.

The pentode arrives

During 1931, the Americans finally adopted the pentode output valve which could generate twice the power of the inefficient 45 with only one third the grid drive — easily delivered by conventional resistance capacity coupling. The Loftin-White amplifier with its requirement for an HT of 450 volts could not compete, and soon took its place in history as a significant but short-lived development in a rapidly changing technology. ■

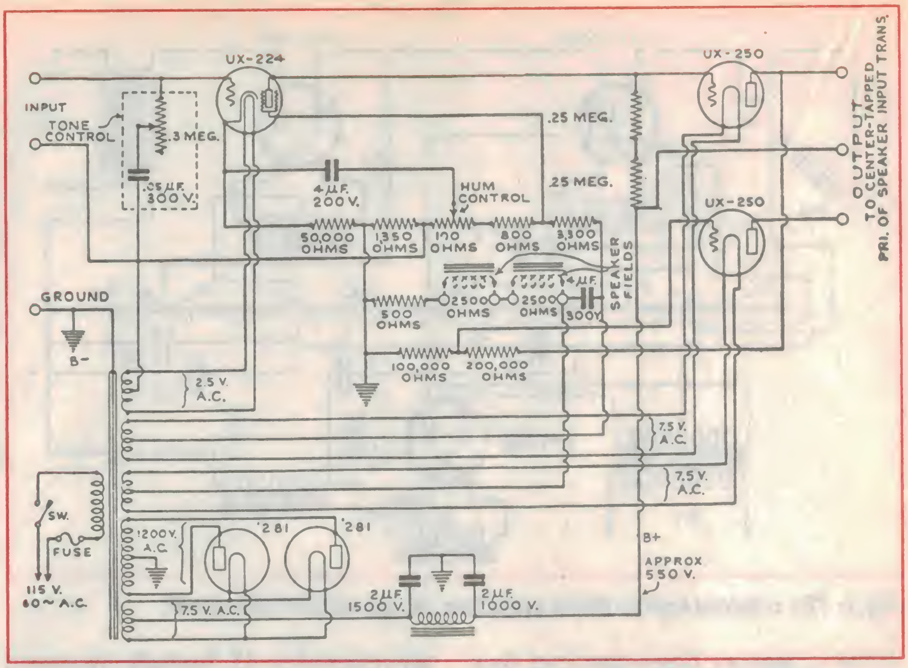


Fig.4: A 10 watt push-pull version. The lower type 250 output valve acts as a phase inverter, direct coupled to the upper valve's anode via a resistive divider.

Here It Is!

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Direct Coupled 245 Amplifier

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An advertisement for Loftin-White kits, from the May 1930 issue of US magazine 'Radio News'.

Experimenting with Electronics...

by PETER MURTAGH

1 - Simple Siren

Welcome to a new series of simple construction projects which we hope will help newcomers get started in the fascinating field of electronics. Our first project is a simple, two-transistor siren — loud enough to demand attention, but not so loud that it drives everyone else out of the house!

What should be the basis of our new series? Where do you start when there are so many possible circuits for a newcomer to try building?

We thought that it would be best to limit our designs (at least to begin with) to using separate transistors, diodes, resistors, capacitors etc. and avoid IC chips. This makes it a lot easier to understand how the circuits work.

Also, we decided, for safety, simplicity and low cost, that all the projects would be powered by an ordinary 9V battery. (Perhaps, at a later date, we might publish a simple power supply.) And finally, to make it as easy as possible to construct our designs, two physical wiring layouts will be provided: an etching pattern for those who wish to make their own printed circuit board (PCB), plus a strip-board (or 'Veroboard') design.

The latter will also provide a layout for those who wish to use a cheaper method of construction, like matrix board, or holes drilled in a piece of masonite.

The projects themselves will be chosen on the basis that they should be fun to build and use. To make the role of each component obvious, modifications of the circuit will be suggested.

We have several ideas for future circuits like a light-activated switch, a simple intercom etc. But maybe you have better ideas. Write and let us know what they are.

Perhaps in the future we could run a competition for the best problem needing a solution, and then follow that up with the best solution provided by one of our readers?

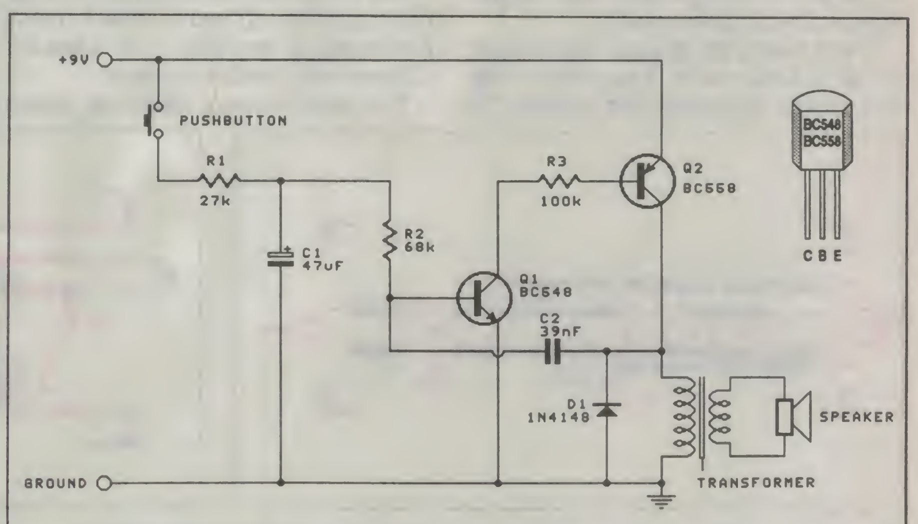
Project No.1

If you look carefully at both layout designs for this first project, you will notice that there seems to be spare space

— extra rows on the strip-board and positions for extra components on the PCB. This is deliberate! You will need that space to add a few more components for a future extension. (Project No.3 will link together our first two circuits).

Construction

If you are using strip-board, first mark the spots on the copper strips where the tracks have to be broken. These are shown on Fig.1 with small crosses. To make certain that you have marked these



The schematic diagram for the circuit. Pressing and releasing the pushbutton increases and decreases the frequency of the siren, causing it to 'wail'.

spots correctly, it's a good idea to first insert all the components on the board to check the layout. Mark the spots and then remove the components.

The easiest way to make the gaps in the tracks is to use a 3mm (1/8") drill bit in a hand drill. Using the V-shaped cutting tip of the drill as a 'countersink', slowly drill away the copper until you just cut right through the track. But be careful not to damage the tracks on either side of the one you are drilling, or to drill right through the board.

Then re-insert and solder the resistors, capacitors, diode and transistors, making sure that capacitor C1, diode D1 and transistors Q1 and Q2 are all inserted the correct way around. Otherwise the siren won't work.

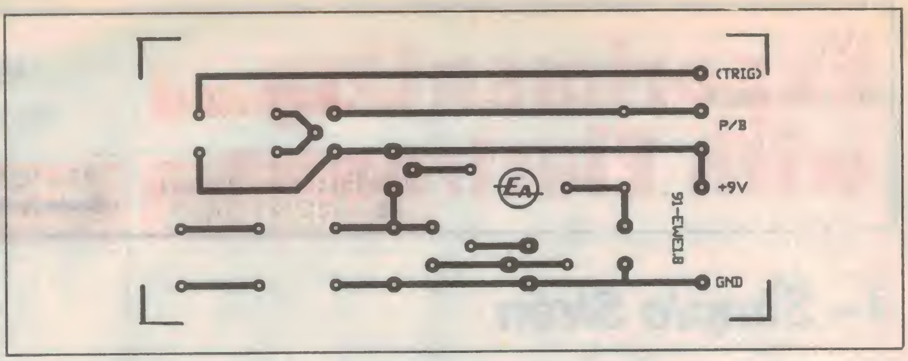
To get the correct orientation, refer to Figs.1 and 2. The negative end of C1 is at the bottom of the diagram in both layouts, while the negative end of D1 (shown with a band) is at the top.

Next look at the transistors. If you hold them with their flat face towards you and the leads pointing down, then the left lead is the collector.

For the strip-board version (Fig.1), the collectors of both transistors are towards the bottom of the diagram; in the PCB version (Fig.2) only the collector of Q2 is towards the bottom — Q1's collector is towards the top.

Now add the miniature audio transformer and small speaker. The input side of our transformer (1k ohm side) has three leads which makes it easy to identify. Bend the centre lead, which isn't used, out of the way. This input side goes to the left. The eight ohm side, on the right, connects to the speaker.

If you mount the speaker vertically, it makes a better noise. Lying flat on its face makes the sound a bit muffled. To do this, we made a stand from a hollowed-out piece of polystyrene foam as shown in the photo.



For those who wish to make their own printed circuit board, here is a full size copy of the PCB pattern.

Finally, connect the pushbutton and battery, and sound away! Notice how the siren builds up to its full pitch when you first push the button, and then dies away when it is released. Project 3 will show you how to do this automatically.

Changes

The pitch of the siren is dependent on the value of C2. With the 39nF value, it sounds like an air raid siren. With an 8.2nF capacitor, it sounds more like a police siren.

Try various values and hear the difference. The smaller the capacitor, the higher the frequency.

Also, try varying the size of capacitor C1. The larger its value, the slower the sound of the siren builds up and dies away. With 22uF it changes very quickly, but with 100uF it is quite slow. Our value of 47uF is a compromise.

How it works

The heart of the circuit consists of the two transistors, Q1 and Q2 which form a non-inverting amplifier, with capacitor C2 providing positive feedback.

The non-inverting amplifier means that as soon as Q1 starts to conduct, then so does Q2. The positive feedback means that the slightest increase in Q1's base current quickly becomes a large increase. The feedback also works in reverse — a slight decrease in current quickly turns the current right off.

So the circuit functions as an oscillator, rapidly turning on and off, producing the siren frequency. The pitch is easily altered by changing the value of C2, because this affects how quickly the changes at the output of Q2 affect the base current of Q2.

What turns Q1 on?

Pressing the pushbutton applies only a very small fraction of the supply voltage to the base-emitter junction of Q1 — this voltage is insufficient to provide enough base current to turn the transistor on.

But pushing the button also starts to charge up capacitor C2, via R1 and R2, and the capacitor soon provides enough 'push' to increase the base current.

The moment Q1 starts to conduct, then so does Q2, with the positive feedback rapidly driving both transistors on harder.

What turns Q1 off?

C2 now starts to charge up again, but this time in the *opposite direction.* Originally, the charging voltage on the

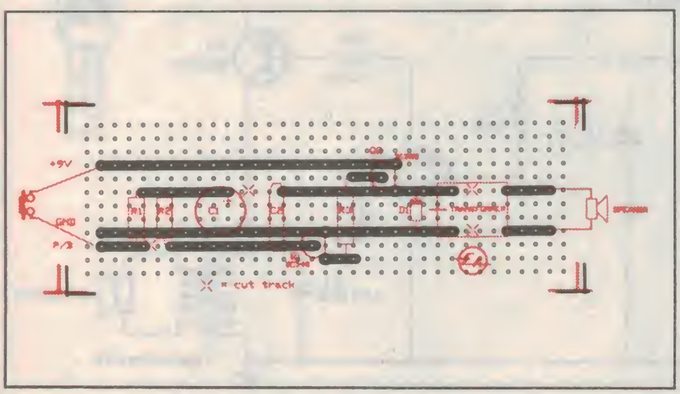


Fig.1: The circuit overlay for the strip-board version. The spots on the track to be cut are marked with an 'X'. Take care to insert C1, D1, Q1 and Q2 correctly.

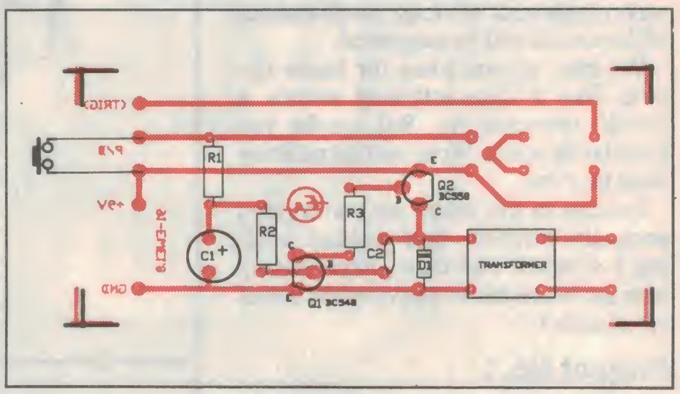


Fig.2: The printed circuit board overlay. The speaker (not shown) is connected to the output of the transformers the same way as shown in Fig.1.

PARTS LIST

Miscellaneous

1 9V battery
1 8 ohm speaker
1 1k/8 ohm miniature audio transformer
1 momentary-make pushbutton

Resistors

All 1/4W, 5%:
1 27k R1 red-purple-orange
1 68k R2 blue-grey-orange
3 100k R3 brown-black-yellow

Capacitors

1 47uF 25V PC-mount electrolytic
1 39 nF 'greencap' polyester

Semiconductors

1 1N4148 diode
1 BC548 NPN transistor
1 BC558 PNP transistor

left side of the capacitor was about +0.7V (the voltage across the base-emitter junction).

But now, with Q2 conducting, the voltage at the right hand side has risen to about +8V. As far as the base of Q1 is concerned, C2 is now discharging, as the base-emitter voltage is dropping.

So the base current decreases, and the positive feedback means that the two transistors rapidly turn off. Once off, feedback ceases, and so the cycle starts over again.

Another factor which influences the siren's frequency is the supply voltage. The pitch increases if the voltage increases and vice versa.

So when you first press the pushbutton, capacitor C1 slowly charges — this increases the voltage available to charge C2 via R2, and hence increases the frequency.

When the button is released, the reverse happens: the frequency drops along with the voltage. This rising and falling pitch makes the siren wail.

The reason for adding diode D1 to the circuit is to make a more pleasant sound. The output of Q2 is a series of pulses, but with very sharp peaks caused by the rapid turning on and off of the transistor, and the resulting rising and falling of the field in the coil of the transformer.

These peaks produce a very high, penetrating and annoying sound, superimposed on top of the basic siren frequency.

Diode D1 eliminates the worst of this unwanted sound by allowing the negative half of the wave to bypass the transformer and speaker.

Try listening to the siren without this diode, and you will certainly hear the difference!

If you intend to experiment with the different value capacitors as suggested, don't solder them firmly in place until you are happy with the sound produced.

But remember that our final values were chosen with a view to using project No.2 (a light flasher) to take the place of the pushbutton.

For this reason, you might like to use our values for your final circuit.

One final comment. Why this circuit works is actually quite complicated, so if you make alterations, for example use different transistors to the ones specified, the amplifier might fail to oscillate.

In the event of this happening, try increasing the value of resistor R2 in order to decrease the base current in Q1.

Transparencies

As part of *EA's* reader services, high contrast, actual size transparencies (negatives) of PCB patterns are available for anyone who wishes to make their own printed circuit boards.

Normal cost is either $5 or $10 depending on size. But because the circuits in this series are very small, we can offer them at a special price of only $2 (which includes postage). Of course, this low price *only* applies to circuits for the 'Experimenting with Electronics' series.

Happy experimenting — and remember to send us your ideas for future circuits. ■

SHORTWAVE LISTENING

by Arthur Cushen, MBE

Rating incoming signals

Continuing with the theme of the new radio listener, we look at a simplified method of reporting signals, the SIO code. Gone are the days of SINPO and of course the Q code for radio amateurs. This new, simple method of reporting reception uses a three point rating for each of three main areas: signal level, interference and the overall merit of the signal.

In the past, when trying to describe the strength, quality and performance of signals received from shortwave stations, listeners have used the SINPO code to describe five ratings of the station's signal. These were listed as S for signal; I interference, N noise; P propagation and O overall merit. All used a scale of one to five.

Broadcasters, on the other hand, have moved into a simpler type of signal measuring and use a three code system SIO: signal, interference and overall merit. This is the case with my monitoring of BBC, Radio Canada, Voice of America, Radio Nederland, Radio Sweden and the Austrian Radio. Only the Vatican Radio continues to use the SINPO code.

The reason the SIO code was developed was that in the old system, many shortwave listeners were not able to define the propagation performance of signals they received and were not familiar with the day to day changes in reception patterns. This also happened with N, for noise, when listeners could not define the noise source and so could not add this information to their reception report.

Instead of using five levels of rating, as used in the SINPO code, the SIO code uses only three levels: two, three and four. This new scale should suit most listeners since most do not use the S meter on their receiver but judge signals from experience and from comparing one signal with another. The S rating of four corresponds to the strength of a local mediumwave station, so in that case, the shortwave broadcaster would be more than happy to receive such a rating. As the BBC says, a signal stronger than four is a bonus, and therefore the signal five is never used. Three stands for moderate and two for weak signal level. S-2 rating is generally looked at as having 'no strength at all'. It is generally so poor that it is of no entertainment value.

When we use the I for interference, this covers four as slight, three as moderate and two as severe. This covers heterodynes, co-channel interference or adjacent channel interference from another station. In your report you give the frequency and location of any interfering station. The O column (overall rating) is an average of the other two figures and its scale is: two - poor, three - fair, and four - good.

The SIO code may not be as comprehensive as the SINPO code, but the listener can and should — extend his

AROUND THE WORLD

CAMBODIA: Phnom-Penh broadcasting on 11937kHz has news in English at 1200UTC, generally with a woman speaker. At 1213 there is music, and following an announcement in French, news in that language is broadcast with a male speaker at 1217-1230. Here in the South Pacific signals are rather weak on this transmission.

FRANCE: RFI has a letterbox programme called 'Club 9516' which is the box number of the station to which mail should be sent. This is heard on Sunday at 1230-1300 on 9805, 11670, 15195kHz; 1400-1500 on 11910kHz; 1600-1700 on 11705, 15360 and 17620kHz.

HOLLAND: Radio Nederland, with its relay through the transmitter on Bonaire, is now using 9630 and 9715kHz for the English broadcast 0730-0825. On Monday-Saturday there is a news feature 0830-0855 carried on 9770kHz. The second transmission for reception in Australia is 1030-1125 on 6020 and 11890kHz.

ICELAND: Reykjavik is well known for its out-of-band frequencies and 6218 and 9268kHz have been heard recently. On Sunday 0700-0800 there is popular English music, followed by bells, news in Icelandic and at 0815 a church service.

NORWAY: Radio Norway recently extended its English schedule from Sunday, to a Saturday-Sunday broadcast. The transmissions beamed to Australia re 1200-1230 on 17820, 21695kHz; 1900-1930 on 15175, 17730kHz; 2200-2230 on 21705kHz. Radio Norway operates a 24 hour schedule with all other broadcasts in Norwegian. On the half hour the transmitters carry the programme of Radio Denmark, Copenhagen.

TAIWAN: The Voice of Asia broadcasting from Taipeh is received on the new frequency of 7445kHz with English 1100-1200. On Saturday, the broadcast consists of answering listeners' letters, and general information about Taiwan. This frequency provides clear reception, unlike in the past when the station was using 5980kHz, a frequency which was difficult to receive.

UNITED KINGDOM: During our winter the BBC is serving Australia with some new frequencies: the period 1800-2300 is now received on 11750kHz; 2000-2300 on 15340kHz; 0600-0815 on 7150, 9640, 11955 and 17830kHz; 0900-1300 on 11750kHz; and 1030-1530 on 9740kHz.

USSR: Radio Tashkent has added an additional broadcast in English 0100-0130 on 5945, 9540, 9600, 11860 and 15470kHz. The regular programmes 1200-1230, 1330-1400 are on 5945, 5940, 9600, 11850 and 15470kHz.

information by including any comment on fading or propagation conditions at the time of reception.

In our monitoring of international broadcasters, there is also provision to indicate several other aspects of interest concerning a particular signal. The Voice of America lists Heterodyne, Atmospherics, CW, Jamming, Voice Modulation and Fading. Heterodyne is a whistling sound produced by a station on a nearby frequency; Atmospherics — atmospheric noise or propagation problems; VC — morse code or RTTY interference; Jamming — intentional interference on the same or an adjacent frequency; Voice — voice interference on the same or an adjacent frequency; Modulation — modulation problems from the transmitter site; and Fading — signal level varies due to ionospheric fading.

Overall, the new SIO code makes it easy for the new radio listener to grade the signals he is receiving. The local station is used as a reference point, since it transmits a consistent '444' signal. Any signals received are compared to this. And since SIO is the broadcaster's code, any reports sent back to them will be easily understood.

East European radio

In recent months, the new shape of broadcasting in Eastern Europe has emerged, with propaganda no longer a major part of their broadcasts. New stations have been heard, schedule changes made and in some cases, budget cuts have reduced operating services.

Recently Soviet President Mikhail Gorbachev issued a decree forming a new company, the 'All Union State Radio and Television Broadcasting Company'. Its role is to control national radio and television, and its new director is the former head of the Tass News Agency.

Early indications are that Radio Moscow World Service, which is broadcast 24 hours a day in English, could reduce its output. A new station called 'Russia's Radio', an independent broadcaster, is using the facilities of Radio Moscow, and is carried on the All Union second programme, reaching about 40% of the Russian population. Russia's Radio operates 1100-1400 and 2200-2400UTC on many shortwave frequencies including 9550, 9570, 9585, 11690, 11840 and 15630kHz.

Radio Prague in Czechoslovakia has reduced its broadcasting output — its English transmissions to the South Pacific are 0730-0800 on 17840 and 21705kHz. This broadcast is now on a daily basis, while the service to North America, which is heard in our afternoons 0300-0330 on 7345kHz, shows a reduction in the length of the broadcast and the use of only one frequency.

Hungary has also announced some major changes which were to take place on June 30. On that date there was planned to be a budget cut of 50% of Radio Budapest External Services.

The Foreign Ministry now provides the funds for Radio Budapest, and the first change that listeners will notice is that the six frequencies formerly used for English broadcasts have been reduced to three. These three frequencies will continue to transmit only English programmes, but the transmissions hours may be reduced. The DX programme from Budapest which has been broadcast 18 times a week will also suffer a reduction in air time. A re-structuring of Radio Budapest is taking place, so the full implications of these changes will not be known for some time. In the meantime, broadcasts in English from Poland to our area continue as normal, at 0630-0700 on 7270 and 9675kHz. Romania also can still be received 0645-0715 with the best reception on 11940 and 15380kHz. Yugoslavia in their transmissions in English 1930-2000 are using 15165 and 17740kHz, while Albania — the last country to move away from the communist rule — is received 0800-0830 on 9500 and 11835kHz.

Jailed for listening

Well known Bulgarian listener Rumen Pankov was imprisoned from late 1974 until May 1979 by the Bulgarian authorities, for listening and contributing to shortwave programmes. He was classified as a member of 'western espionage' DX Clubs. Not until November 1989, was he able to resume his radio listening without fear of upsetting the authorities.

Rumen has indicated by letter to the writer that he can now follow shortwave broadcasting without restriction and that he has been able to write to many shortwave broadcasters. He has often heard my own voice on Radio Nederland and HCJB Quito, Ecuador. ■

This column is contributed by Arthur Cushen, 212 Earn St, Invercargill, New Zealand, who would be pleased to supply additional information on medium and shortwave listening. All times are quoted in UTC (GMT), which is 10 hours behind Australian Eastern Standard Time.

Trip Meter

Continued from page 99

each diode and how to select the required diodes. It's basically a decimal to binary conversion, using diodes.

After you've worked out which diodes are required, install them. Then change the link so that it connects points X and Y.

Installation

As for any installation of this type, use wire with relatively thick insulation for best protection and fit rubber grommets to holes for the wires to pass through. It's also a good idea to form the wires into a loom, either taped with PVC tape or bound with nylon straps.

As the various diagrams show, the trip meter requires two 12V supplies: one that is permanently connected and another (for the displays) that turns off with the ignition. These can usually be obtained from the vehicle's fuse box.

To allow the dimming circuit to work, a connection is also required to the vehicle's lighting circuit, usually the headlights. You may be able to pick this up at the fuse box; otherwise run the wire to either of the headlights and connect it at the lamp socket.

Then mount the unit so it is out of direct sunlight, so the display can be read during the day. Also, the switches should be in easy reach for the driver. Otherwise, that's it — another handy extra to make driving more pleasurable. ■

Information centre

Conducted by Peter Phillips

Environmentally sound advice

As ever, I have for you a mixture of ideas, comments and technicalities. And in an oblique way, the environment gets mixed in with two letters. Maybe not the original intent of the writers, but appropriate perhaps.

These days awareness of the environment has become an issue that interests us all. Many readers probably check to see if the propellant of a spray can is environmentally 'friendly', and the efficiency sticker is something many people look for when purchasing appliances.

The possibility of power generation using alternative energy sources to coal is also of interest, as is the concept of reducing waste.

When I was a lad it was usual to recycle old components and hardware, as the throw-away society had yet to be invented.

Even today, I still cringe when I see a perfectly good resistor accidentally sucked into the vacuum cleaner. I occasionally dig into the dustbag to retrieve it, even though it costs less than a couple of cents. A habit maybe, but one I suppose that's becoming more fashionable.

I'm prompted to write these lines by two letters; one that asks about switch-mode output stages for audio amplifiers, and another that suggests a good use for old 12V car batteries. You might wonder how a switch-mode output stage can be seen as environmentally friendly, but as I see it, anything that works more efficiently has to be a step forward. Imagine the power savings on a national level if all power amplifiers were say, 90% efficient.

And any letter that suggests how old components can be re-used will always get a priority in these columns. So there's yet another topic we can explore. As usual, your own ideas are welcomed.

And so to the first letter, which may seem slightly pedantic but relevant nonetheless.

Emitter resistors

The Basic Electronics series currently appearing in the magazine has attracted quite a few letters, including the following which concerns the correct labelling of the emitter resistors in a transistor amplifier.

Perhaps you could clarify a few points raised by Part 11 (May 1991) of your useful series on basic electronics. The text and even the Table of Equations seem to treat the labels RE and Re alike. Under the heading DC Conditions, Re is used, while in Fig.6 it is RE. Under Emitter Bypass Capacitor, the bypassed resistor is Re, but in Fig.7 it's RE.

Also, shouldn't DC V and I labels use upper case subscripts, with lower case for AC signals? In the table, shouldn't the extrinsic emitter resistance be RE + Re = VE/IE? (For voltage gain, it is re that equals 30mV/IE, not Re as shown.) (G.L., Redfern NSW).

The topic of labelling resistors in transistors might seem trivial, but I agree with G.L., and certainly there is some inconsistency in the article. Worse, there is a mistake in the Table of Equations.

The convention I normally use is: RE for resistors that pass DC currents only, Re for those that pass DC and AC currents, and re for the intrinsic emitter resistor of a transistor. Thus a bypassed emitter resistor should be RE, and an unbypassed resistor is Re. The circuit of Fig.7 in the article is therefore incorrectly labelled. As well, the table should read re = 30mV/Ie, not Re as shown. Fortunately, the text is correct; it seems I've slipped up on the diagrams and the table.

Concerning upper and lower case for AC and DC, the usual convention is as G.L. states, although sometimes this can cause confusion when lower case is used. For example, writing vin and vout for input and output voltages might have some readers scratching their head wondering what a 'vin' or a 'vout' is.

Ideally, the in and the out should be printed as a subscript, but this can sometimes make the text hard to read and rather untidy to look at. For this reason, we generally use Vin and Vout, Iin and Iout and so on, for AC and DC values alike, despite the technical inaccuracy. It's a limitation we have to live with. But thanks for the corrections concerning the emitter resistor labelling, I'll be more careful with this one. And on the subject of mistakes in this series, here's yet another...

'317 error

It seems the letter by P.G. in May commenting on my treatment of the '317 voltage regulator missed an important error on my part:

It wasn't until I read P.G.'s letter in May that I looked back at the original article. The formula is upside down! It should be 1.25V(1 + R2/R1). It makes the description of operation much easier, and P.G.'s comments then become meaningful. (P.R., Taroona Tas).

There's no doubt about it, the equation in the article (January 1991) is wrong. Worse still, because the description follows the equation, the description is also wrong. A compounding set of errors that seem to go from bad to worse. If the

opportunity allows it, about all I can do is try again in another section of the series!

Without trying to make excuses for mistakes, I take heart from the experiences of other technical writers who all point to errors they have made in technical descriptions. It's difficult not to slip up occasionally, explaining why the second edition is always the better edition.

Tracking problems

These days it's easy to forget the problems that supply voltages of 200V or so can cause. Like the following...

Your 'Spray it again, Sam' comments in the May issue prompt me to mention a surprising problem I have encountered in the use of moisture dispelling liquids on radio equipment.

They are great for cleaning contacts on wafer type wavechange switches, but twice now I have been caught out while servicing valve receivers. On both occasions I squirted a dirty wavechange switch when the receiver was operating. There was immediate arcing from segments connected to the high tension voltage, followed by carbonisation and destruction of the switch wafer.

It would appear that despite their moisture dispelling properties, and claims about starting wet engines, these liquids can be conductive and should be allowed to evaporate before switching the power on. (P.L., Invercargill NZ).

An interesting story, P.L., and a worthy reminder. On a slightly related topic, I recall sometime ago placing a circuit board on a bed of neoprene rubber, only to find the circuit behaved in a very strange way.

It took quite a bit of time and fruitless fault finding efforts before I discovered that the neoprene rubber was in fact conductive. A 50V supply on the circuit was tracking to other low voltage sections, fortunately without causing damage — but sufficiently to upset the operation.

I later learnt that the rubber was carbon impregnated, for reasons I have yet to figure. Seems you can't trust anything these days!

A 6V battery

There's no doubting the ingenuity of some people, particularly those from the land. While the technological content of the next letter is rather low key, the outcome is extremely useful:

Who needs a 6V battery these days? In my case, I need one to supply an ageing Wolseley electric fence. For the non-agricultural city slickers, time was when nearly all electric fences were electro-mechanical contraptions driven by a 6V battery. These devices emit a satisfying mechanical 'click...click...click' as the contact wheel oscillates, unlike the fearsome electronic models now. I bet there's still quite a few old red Wolseleys sitting out there now.

New 6V batteries cost plenty, but discarded 12V car batteries can be had from almost any garage for the scrap metal value of a dollar or two. Tested with a hydrometer, most of these show five cells still OK, but one cell down. Could one just cut off three cells including the dead one, and continue to use the other three? Yes indeed! It takes all of 10 minutes and just a little common sense.

Let's agree to call the three cells we're going to keep numbers 1, 2 and 3. We'll cut the battery casing with a hacksaw blade, cleanly across the middle of cell number 4. Then discard the innards of cell 4, together with cells 5 and 6. Electrical connection to cell 3 at the cut-off is easily made, via the sturdy lead strap that emerges through the cell wall at the cut.

Common sense is needed to deal with the acid problem. In my case, the acid from the discarded cells was drained out into a plastic bucket containing several cups of garden lime in water. A bit more lime was flushed into cell 4 before sawing commenced, to neutralise the remaining acid. No problems with safety. The neutralised residue is only calcium sulphate, after all — the same as 'plaster of Paris'.

The result of all this is an electrically complete 6V battery, good for a year or two yet. Sure it lacks cosmetic appeal, but the cows don't seem to mind. Although I haven't tried it yet, but a small bank of these 6V units could probably be coupled up to make a respectable lighting system for remote areas, without the considerable cost of the usual lead-acid batteries. (R.G., Gerringong NSW).

When you think about it, this idea has many applications. For the cost of two faulty batteries, a good 12V unit could be made, suitable for the many stationary applications that use a 12V supply.

It's environmentally sound, as it recycles old batteries and a very substantial power supply can be obtained for peanuts. Charge it with a solar generator, and it costs nothing except the capital outlay.

Thanks R.G., I'm sure your idea will be extended beyond cow control by quite few readers!

Switch-mode amps

The days when an audio amplifier was a simple linear system are no doubt numbered, with the advent of the digital audio amplifier that integrates nicely with the digital compact disk.

However, the one section that causes angst among designers is the output stage. How does one get lots of power with minimal distortion and heat dissipation? Perhaps the next letter has the answer...

I service switch mode power supplies for video amusement machines. I see the possibility of using this principle for high power audio amplifiers, instead of the usual linear design. Suitable ICs, transistors and ferrites are widely available to make this a reasonable option. I think some amplifiers already use this principle — perhaps you might like to consider designing one as a project. (B.C., Gunnedah NSW).

I seem to recall such designs, although I suspect this principle would be limited to high power amplifiers, such as those used for outdoor concerts.

The idea of being able to achieve a higher efficiency for a sound system delivering 50kW is no doubt attractive as the mains input power is around 100kW, even assuming an efficiency of 50%. This equates to a single phase line current of over 400A, so reducing the input power is in everyone's interest.

As well, the physical size of the unit would be smaller and the heat dissipation much less. Thus, power to run fans and other cooling systems could be dispensed with, giving a power saving here.

The question of such a project being (a) achievable and (b) attractive to readers is another matter. Over the years, various high power amplifier designs have been produced as magazine projects, and in most instances the 400W output power available from some of these designs is all most readers want.

However, as technology advances, it's likely we'll see switch-mode output stages become more common. And maybe one of ours could be among them — who knows.

The toidi

I initially decided not to reprint any letters concerning the 'translated' article on Current Direction (April 1991), but the following letter relates the toidi very nicely to the rather esoteric topic of speaker cables:

After reading with interest the article on current flow direction, I feel your translator may have been in error! The metal referred to as 'Grunnherder' metal is actually Gnirrehder metal, and is a proprietary name of a non-ferrous steel produced by the Lirpa-Werke A.G. of Krankenhaus Am Kopf, Germany.

INFORMATION CENTRE

On the subject of the toidi, these were discovered by sheer luck when using these new non-ferrous steels to make speaker cables that are uni-directional! That is, they have a diode action, creating a no-loss cable with an infinite velocity factor.

Perhaps those audiophiles who believe (wrongly!) that oxygen free copper is a good substitute for audio cable might be interested. Thanks for the fun. (G.M., Northfield SA).

And thanks for taking the joke a bit further, G.M. I'm told that up-market, new generation speakers will use the Wollings coil as the speaker coil, so who can tell what the future holds. But a non-ferrous steel has me wondering!

The April What??

The April edition of the magazine has resulted in quite a few letters concerning the magical toidi and the What?? question. While most readers were aware of the relationship between the toidi and the month of April, quite a few readers have supplied answers to the What?? question that are, in a word, wrong.

As I stated in the question, this is one I'm sitting back on, as it all seems rather weird to me.

Fortunately, not all letters on the question are giving the wrong answer, such as the following:

The What?? question regarding the two series-connected ideal transformers in the April issue caused quite a bit of controversy among friends and colleagues of mine.

The controversy stems from the fact that many people confuse 'ideal' transformers with 'perfect' transformers. An ideal transformer is a mathematical tool used for network analysis and does not exist in practice, so the proposed circuit cannot exist either.

However, if a perfect transformer is used, a somewhat different result is obtained. A perfect transformer can in theory be approximated by a 'real' transformer to any degree of accuracy.

(The letter continues with a mathematical proof using 4-terminal network analysis that validates the answer given in May.

It concludes with the following:)

The problem is interesting because it has a practical application. A circuit using only transformers, resistors and capacitors is used to generate a frequency of 16.67Hz from the 50Hz telephone ring signal.

The situation is analogous to the use of a motor-alternator set used to generate an out of phase voltage for power factor correction in power distribution systems, where the alternator acts as a transformer and the resistance can be represented by the mechanical input into the alternator. (G.M., South Oakleigh Vic).

What??

This tricky little question is extracted from the circuit of a regulated power supply. The question is, calculate the value of the currents in both zener diodes. (Fig.1 below).

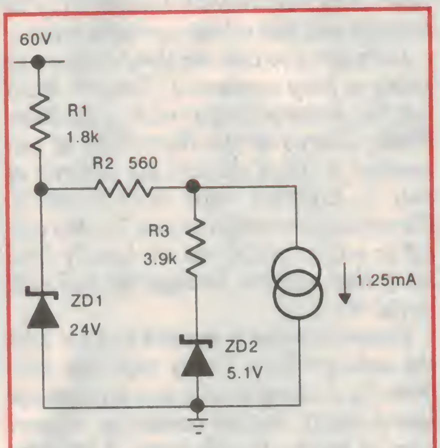


Fig.1

Answer to July's What??

The meter current is 0.5mA. The voltage across R1 will equal 50mV, and this voltage will also appear across R2 as the voltage between the input terminals of the op amp is zero.

By Ohm's law, the current in R2 equals 50mV/100, giving 0.5mA. Notice how R3 plays no part, and is simply a series protection resistor for the meter movement. ■

Notes and Errata

We would like to pay Robert Marazzato of Reservoir Vic, for his contribution to *Circuit & Design Ideas*, published in the June issue, but we have mislaid his address. Robert, please contact us for your money.

QUAD DI BOX (June 1991): The schematic diagram on page 65 shows pins 9 and 10 (and their matching +/- symbols) of IC1b transposed. As you would expect from the circuit's operation, the op-amp's non-inverting input (pin 10) should be connected to R6, while the inverting input (pin 9) should connect to the junction of R4 and R5. The PCB and overlay diagram are correct. ■

Interface for PCs

Continued from page 89

motor, in order to vary its speed. The contacts of the various relays would be used to connect the motor to its supply via a set of resistors, with values weighted in binary sequence so they each result in binary weighted current levels: 1 unit of current, 2 units, 4 units and 8 units. Then it would be possible to vary the motor current through 16 levels, giving quite a reasonable degree of control.

This would be a crude 4-bit digital-to-analog converter, of course. You could achieve the same result a little more elegantly by using the four inputs to drive four transistors (or four CMOS switches) with binary weighted series resistors, to vary the output of an LM317 or similar voltage regulator IC, to drive the motor directly.

A similar scheme could also be used with a modified version of the triac driver module, so that the four MOC3021 couplers, still driven by the same number of interface output bits, were used to turn on a single triac but with varying phase delays before conduction — adjusted to give 16 different brightness levels. This would allow programmed dimming of stage lighting, as well as sequencing... Of course there's no reason why all eight output lines of an interface couldn't be used to drive an 8-bit DAC chip such as the DAC08, to provide an output DC current variable over a full 256 levels. This could then be used to drive a DC power amplifier, to control a motor or whatever.

In principle the basic system can be adapted to do almost any kind of multi-level control, with the ability to adjust the number of levels you want simply by choosing the number of bits you allocate to control each output. Four bits gives 16 levels, five bits gives 32 levels, 6 bits gives 64 levels and so on — it's a simple power-of-2 relationship. The advantage of selecting a small number of output levels, if they will be adequate for your purposes, is that this will often allow you to simplify the circuitry.

As you can see, there's really a lot that can be achieved using quite simple hardware, to adapt your computer for monitoring and control. Why not try experimenting in this fascinating area?

If you'd like to see a bit more on this subject in *EA*, let me know. And if there's enough interest, I'd be happy to develop further modules to extend the system. ■

EA with ETI marketplace

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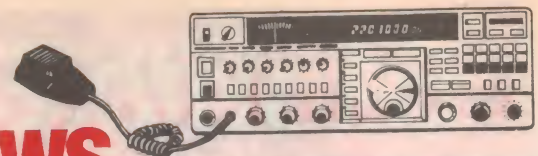
Amateur Radio News



2m Transceiver kit now available

We have been advised by Dick Smith Electronics that kits for the new 2-metre FM Transceiver (described in our January-April 1991 issues) have now been released, at last. The delay was apparently due in part to late arrival of some of the key components from overseas, but also because DSE's R&D department decided to hold the kits back for a short time while they did a little 'fine tuning' to the design, to improve the Transceiver's performance in a couple of areas.

But the parts duly arrived, and the fine tuning was completed, so the kits are now available. We hope to publish shortly details of the minor improvements which have been made to the design, for the benefit of any amateurs who may be tackling the project 'from scratch'.

International study guide available

The ARRL has sent news of a new book that has just been published by the International Amateur Radio Union (IARU), called the *International Amateur Radio Study Guide*. It's intended to be used as an introduction to amateur radio anywhere in the world, and is claimed to contain all of the basic educational material needed to become a licensed 'ham' in any country — although at present only an English-language version is available. The ARRL also points out that supplementary information may be needed in any particular country, in order to meet any special licensing provisions that may apply.

The book has 180 pages, divided into 11 chapters. These cover an introduction to amateur radio, the radio frequency spectrum, use of Morse code, basic theory, circuit components and practical circuits, selection of equipment and antennas, assembling a station and getting on the air, and troubleshooting.

Copies of the new book are available direct from the ARRL for US$19, but payment must be made in US dollars. Orders should be directed to Debra Jahnke, American Radio Relay League, 225 Main Street, Newington CT 06111, USA.

1991 RD Contest

From a recent weekly broadcast of the NSW Division of the WIA, we gather that this year's Remembrance Day Contest is to be held this month on the weekend of 17-18th August.

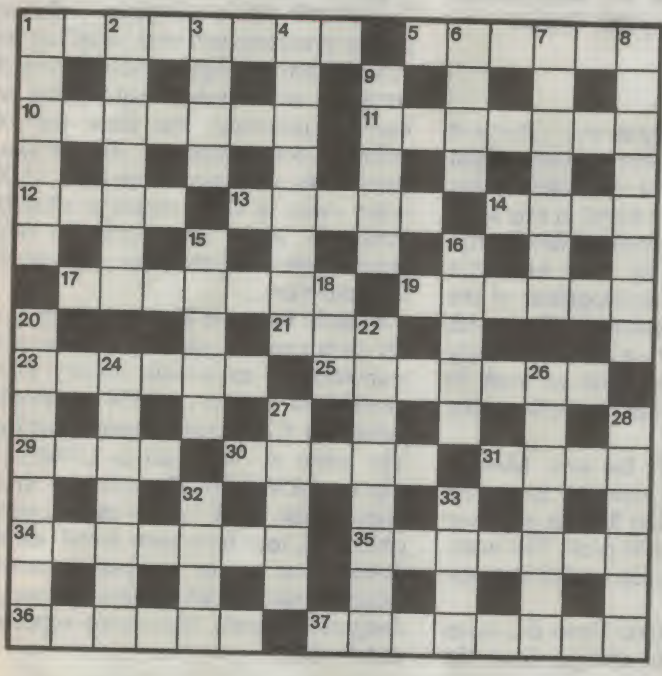
So far there's no sign of any re-allocation of the date which caused a certain amount of confusion for last year's RD Contest. ■

During a recent overseas visit, Sam Voron VK2BVS, the Australian director for IARN, visited his Bangladeshi equivalent Tuimur Rahman, in Dhaka.

EA CROSSWORD

ACROSS

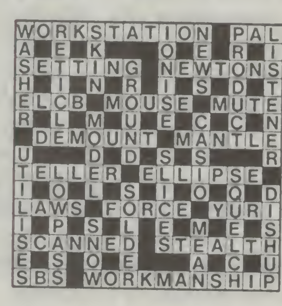
1. Tools with teeth. (8)
5. Seek response on CB. (4,2).
10. Hand-driven component. (4,3)
11. When will loose wiring blow the fuse? (7)
12. Said of certain numbers. (4)
13. Well known brand of cartridge. (5)
14. Basic aerodynamic force. (4)
17. Descent of particulate atmospheric pollution. (7)
19. Nationality of 31 across. (6)
21. A memory. (3)
23. Name of effect opposite to the Ettinghausen effect. (6)
25. Type of data. (7)
29. Large show. (4)
30. Said of broad spectrum noise. (5).
31. Co-discoverer of nuclear fission, Otto ----. (4)
34. Video shot with small range. (5,2).
35. Isotope of hydrogen. (7)
36. Metal oxide transistor. (6)
37. Part of a battery. (8)



DOWN

1. Made noise by feedback. (6)
2. Unit of luminous intensity. (7)
3. Major manufacturer of electronic goods. (4)
4. Unit of energy. (4-4)
6. Particle. (4)
7. Lightest metal. (7)
8. Name of vector indicating energy flow in an e-m field. (8)
9. Prefix meaning star. (5)
15. Visible effect of discharge. (5)
16. Diode named after American physicist. (5)
18. Trig ratio. (3)
20. Communication circuit. (8)
22. Manifold. (8)
24. Again marks position. (7)
26. Nationality of Volta. (7)
27. Processed semiconductors. (5)
28. Surface finish. (6)
32. Prefix indicating at a distance. (4)
33. Camera facility allowing 34 across. (4)

SOLUTION TO JULY



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6	31	56	81	106	131	156	181	206	231	256	281
7	32	57	82	107	132	157	182	207	232	257	282
8	33	58	83	108	133	158	183	208	233	258	283
9	34	59	84	109	134	159	184	209	234	259	284
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11	36	61	86	111	136	161	186	211	236	261	286
12	37	62	87	112	137	162	187	212	237	262	287
13	38	63	88	113	138	163	188	213	238	263	288
14	39	64	89	114	139	164	189	214	239	264	289
15	40	65	90	115	140	165	190	215	240	265	290
16	41	66	91	116	141	166	191	216	241	266	291
17	42	67	92	117	142	167	192	217	242	267	292
18	43	68	93	118	143	168	193	218	243	268	293
19	44	69	94	119	144	169	194	219	244	269	294
20	45	70	95	120	145	170	195	220	245	270	295
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AUG '91

50 and 25 years ago...

'Electronics Australia' is one of the longest running technical publications in the world. We started as 'Wireless Weekly' in August 1922 and became 'Radio and Hobbies in Australia' in April 1939. The title was changed to 'Radio, Television and Hobbies' in February 1955 and finally, to 'Electronics Australia' in April 1965. Below we feature some items from past issues.

August 1941

Tough on ants: A new American radio detector enables the sound of white ants eating to be heard 30 feet away. Only vibrations peculiar to these termites are picked up by the small radio box.

Successful experiment: An Australian made D104 microphone has been used in police courts. This marks the production, for the first time in Australia, of a high-grade crystal microphone. The first use of the new D104 has been made in the AWA portable amplifier tested in the Sydney Water Police Court. Although microphones and amplifiers have been used in the US by judges' police clerks, this is believed to be the first occasion on which an amplifier has been used for the convenience of witnesses.

August 1966

Japanese developments: Recent developments in the semiconductor field in Japan suggests that the Japanese bid to lead the rest of the world in this technology is not to be dismissed too lightly.

Though eclipsed by their American counterparts in the development of the transistor, they are making up for it with the development of new diodes. Already Esaki and Kita diodes are at work in Japan's microwave link network — the densest anywhere.

Experiments with the new Mizuno diode have seen it operate, in pulsed mode, between 10 and 90GHz at power outputs of up to 10mW peak. The international race to develop a solid state oscillator continues.

From cyles to hertz: From this issue *Electronics Australia* changes from the time honoured terminology 'cycles per second' to the term 'hertz'.

It seems appropriate to coin a phrase or two for amateur use: how about 'kertz' for kHz and 'mertz' for MHz?

Time-sharing: During recent demonstrations at Australian General Electric's computer centre in Sydney, an engineer sat down at a teletype and 'conversed' with a computer — feeding in new programs and data, recalling previously stored programs and having the computer solve typical engineering and business problems. But these were no ordinary demonstrations, for the domputer being used was more than 12,000 miles away at GE's centre at Pheonix, Arizona. More important, 20 other people were using the same computer at the same time...

Atomic battery: The American Martin company is starting commercial marketing of an atomic battery with a guaranteed output of 25W of electric power for five years without refuelling. The price of the unit is US$63,230 (about A$56,900). Developed from thelong line up of 'SNAP' atomic power generators, uses have been found for the batteries as power sources in remote locations such as navigation beacons in dangerous waters, submarine repeaters and the like.

Electronics Australia with ETI

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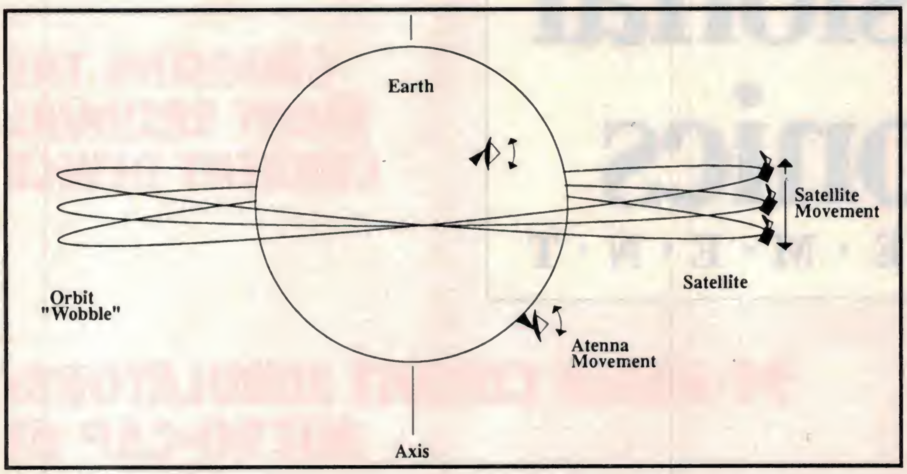


NEW DIGITAL VIDEO COMPRESSION SYSTEM

Satellite-based communications technology specialist Scientific Atlanta has developed a new digital video compression technique which is expected to allow roughly four times the number of TV channels to be fitted within a given transponder bandwidth, improving the potential profitability of Pay TV in countries such as Australia. The new system was recently demonstrated at the National Association of Broadcasters convention in Las Vegas.

Known as vector quantisation or 'VQ', the compression technique operates in real time and provides high quality, full motion video. It lends itself to both satellite and optical fibre reticulation technologies, and is also upwards compatible with the B-MAC system used for satellite TV distribution in Australia and other countries.

Scientific Atlanta has also developed a new add-on tracking system for professional satellite tracking antennas, to allow them to follow the inclined or 'wobbly' orbits adopted by an increasing number of communications satellites as they approach the end of their planned life. Three of the four Intelsat satellites over the Pacific are now in such orbits, to conserve their remaining fuel — which can cause problems in terms of reliable communications, due to their apparent 'figure of 8' motion each day as seen from an earth-based dish.

The new S-A tracking system uses an adaptive and predictive 'learning' algorithm, allowing the antenna to follow the satellite's motion accurately and smoothly despite atmospheric attenuation and other disturbances.

RMIT TO DISPLAY STUDENT PROJECTS

As part of their course requirements, senior undergraduate students in Communications, Electrical, Electronic, Digital Systems and Computers Systems engineering at Melbourne's RMIT (Royal Melbourne Institute of Technology) have to undertake an 18-month design project which is assessed upon completion by the academic staff and in some cases by industry as well. This year RMIT's student-run CEEDS Conference Committee is organising a conference to display and discuss a selected number of these projects, for an audience from industry, electronics enthusiasts and potential students. The idea is to promote both the projects themselves, and also the career of electronics engineering.

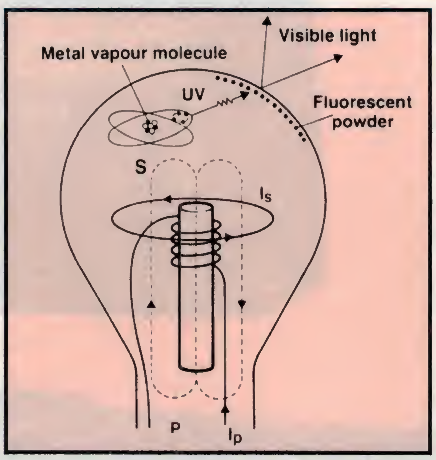
The conference is planned for either late September or early October, and all interested people will be welcome. Further details are available from the CEEDS Conference Committee, care of the Department of Comm. Enginering, RMIT Melbourne.

PHILIPS ANNOUNCES LONG LIFE INDUCTION LAMP

Philips has developed a new professional lighting technology, which allows the production of lamps combining exceptionally long operating life with high efficiency and virtually no maintenance.

The company's new 85-watt 'QL induction lamp' was unveiled recently at the opening of its new Lighting Applications Centre in Eindhoven, which also marked the Philips centenary.

The QL lamp is different from either of the conventional incandescent or gas-discharge varieties, using a high-frequency electromagnetic field to excite metal vapour molecules in the lamp's



glass envelope in place of a filament or discharge. UV radiation from the excited molecules is then converted to visible radiation by a fluorescent phosphor coating on the inside of the envelope, as with a fluorescent tube. The exciting field is produced by a 'power coupler', essentially an inductor wound on a ferrite rod. With no filament or heaters to burn out or lose emission, the new lamp is said to have an operating life of around 60,000 hours — six times that of even a gas-discharge lamp. The HF excitation also offers immediate starting with full intensity, coupled with freedom from flicker or strobing.

The QL lamp can also be dimmed without change in colour, unlike most other kinds of lamp, and due to the electronic drive circuitry it can also be arranged to deliver virtually constant light output despite mains voltage fluctuations.

SONY TO LAUNCH MINI CD RECORDER

Innovative Japanese manufacturer Sony has apparently developed a new and very compact audio recording system which uses recordable mini compact discs, only 64mm in diameter and mounted in a protective cartridge measuring 72 x 68 x 5mm — similar to that of a 3.5" floppy diskette, only smaller. The company is apparently planning to release the system next year, with a portable 'Walkman' type recorder which could make familiar compact cassettes obsolete.

The new discs have a capacity of up to 74 minutes of high quality audio, achieved using a digital compression system called 'ATRAC' — an acronym for *adaptive transform acoustic coding*. ATRAC is apparently similar to the PASC coding used by Philips in its new DCC system, and is claimed to provide a frequency response of 5Hz-20kHz and dynamic range of 105dB at the sampling rate of 44.1kHz. The new Sony recorders will apparently incorporate the SCMS serial copy management system, to prevent more than one generation of digital dubbing.

An additional feature of the new Sony system is an automatic 'shock recovery' facility, giving uninterrupted playback even when the recorder is subjected to physical shock. This has been achieved by incorporating a 1Mb RAM chip in the playback system, as a buffer which holds three seconds of playback audio samples. When the data flow is interrupted due to shock, the playback system can use samples retrieved from the RAM, while it recovers. Automatic catch-up occurs when correct tracking is restored.

The discs using in the system employ the magneto-optical system used in high-capacity computer data storage, but the recorders will apparently also be able to replay standard mini compact discs.

DEVELOPMENT PROGRAM FOR OZ ENGINEERS

In a bid to improve Australia's international competitiveness and accelerate the process of economic change and industry restructuring, The Institution of Engineers, Australia (IEAust) has launched a Graduate Diploma program designed to provide a stimulus to the professional development of the nation's 104,000 engineers.

To be offered through IEAust's recently formed education subsidiary, Engineering Education Australia, the Graduate Diploma of Engineering (Professional Development) is an Australia-wide program designed to provide engineers, no matter where they live or work, with opportunities for increasing their professional knowledge and skills.

Outlining details of the new program offered by IEAust, the Managing Director of Engineering Education Australia (EEA), Dr Maureen Smith said the Graduate Diploma of Engineering (Professional Development) has been introduced to provide access to continuing education for all engineers.

"Whether they work on remote offshore oil platforms, in major industrial plants in urban centres, on a construction site or at a local government level in the hundreds of towns and shires throughout Australia, engineers now for the first time are being given access to a very wide range of subjects that can be studied in their own time to suit individual circumstances."

"Through close consultation with industry, employers and experienced members of the profession, these units of study will equip them to more effectively face the rapid changes occuring within industry, business and the wide community", Dr Smith explained.

Dr Smith said that reaching egineers in remote areas to provide access to the latest skills and technologies had been a major prority for the Graduate Diploma from the outset. She said close working relationships had been established by IEAust and EEA with industry, educational institutions, government education and training foundations and the

OTC ASIC MADE IN RECORD TIME

Australian Silicon Structures has delivered samples of a complex integrated circuit to the R&D Group at OTC Limited in the brief time span of only nine man-months, from commencement of design. A synergistic combination of silicon design software, emulation hardware and quick turnaround electron beam prototyping was exploited to achieve the rapid design-to-delivery cycle of the application specific integrated circuit (ASIC).

The ASIC, a multi channel speech synthesis device designated the S3-16, was developed in conjunction with Syrinx Speech Systems, a leading speech technology company, for OTC. Wide applications exist for the device including a low cost speech based customer interface for information services.

Australian Silicon Structures or 'AS2' is an expert silicon engineering service company based in Sydney. Fast development was achieved by taking advantage of the latest ASIC design methodology, based on silicon compilation tools teamed with high performance workstations to yield a cost and time effective design process. Signal processing algorithms were created directly in a high level hardware description language. Detailed design layout was then compiled automatically in the form of bit-serial VLSI structures, supported by software compiled blocks of memory and logic, all integrated onto a single silicon chip.

NEWS HIGHLIGHTS

engineering profession to ensure that as the program develops it will be very responsive to the diverse and changing needs of the profession and industry.

Engineers and employers wanting further information about the Graduate Diploma, including a special Student Guide (containing a list of participating universities, descriptions of units offered and advice on enrolment procedures and enrolment application forms, should contact Engineering Education Australia in Sydney on (02) 955 8200.

TOSHIBA-IBM MAKING LARGE COLOUR LCD'S

A joint venture of Toshiba Corporation and IBM Japan, Display Technologies, Inc. (DTU), has completed construction of its manufacturing plant in Himeji and started production of large-size, colour liquid crystal displays (LCSs) for computer terminals.

Located 600 kilometres west of Tokyo in Toshiba's Himeji Works, the joint venture produces 10.4" (640 x 480 pixels) colour LCDs, and will gradually add larger size units to its line up. The company has 370 employees and capital investment in the new plant in fiscal 1991 will reach 30 billion Yen (US$214 million).

The new plant is a state of the art manufacturing facility that forms thin film transistor arrays onto large glass substrates, in a class-100 clean room (less than 100 0.5-micro dust particles per cubic foot). This clean room has the similar level of air cleanliness as those used in the manufacture of LSI chips. Total production management is coordinated by using a computer integrated manufacturing (CIM) system.

SUPERCONDUCTING THIN FILM BREAKTHROUGH

Researchers at Toshiba Corporation's Advanced Research Laboratory in Tokyo have achieved another breakthrough in high-temperature superconducting technology.

They have succeeded in creating thin film layers of a bismuth-based superconducting material which enables electricity to flow vertically through the layers with great ease — claimed to be a major step toward the application of superconductors in future electronic devices.

Bismuth-based materials are more stable chemically and become superconductive at a higher temperature (-163°C) than yttrium-based compounds (at -178°C), but are more difficult to form into thin films (a necessary step to develop superconductor electronic devices) because of their complex crystal structure.

One of the problems of superconductor thin films, in particular bismuth-based ones, is that current does not naturally flow easily along vertical axis of the crystal structure. This is a major disadvantage, as it makes it difficult to achieve the ideal 'tunnel junction' that shows the 'superconducting tunnel effect' — an important phenomenon, peculiar to superconductors, that has the potential to be used as the basic switching transistor capability in future electronic devices. To date, it has proved technically impossible to create the crystal layers vertically to a substrate, so that current also flows vertically.

Toshiba's researchers have overcome this problem by developing a new technology to create the crystal layers of bismuth-strontium-calcium-copper-oxygen (Bi-Sr-Ca-Cu-O) slanted against the surface of the substrate (of strontium-titanate-oxygen, $SrTiO_3$).

While current continues to flow horizontally along the crystal, it will ultimately flow from the bottom to the top of the layers, since the crystal layers themselves are tilted — achieving the same results as if current were flowing vertically through the layers.

Toshiba researchers have clarified both theoretically and experimentally the mechanism of creating the slanting thin film layers, by using a molecular beam epitaxy method and controlling the supply of metallic elements and oxygen during the crystal-forming process.

TEKTRONIX RELEASES NEW DIGITAL SCOPES

Tektronix Australia has introduced the first two digitising oscilloscopes built on the company's new Tektronix Digitising Scope (TDS) platform. Each member of the TDS 500 Series packs a novel graphical user interface (GUI), high-speed acquisition, advanced triggering features and multiprocessor power into a mid-range digital scope.

The new TDS520 and TDS540 are both 1GS/s instruments with 500MHz bandwidth and four channels. Both offer variable record lengths of up to 50,000 points per channel, advanced triggering, 8 bit vertical resolution, 4ns glitch capture and 1% accuracy.

For intuitively easy operation, the GUI combines extensive use of screen

NEWS BRIEFS

- ***Chubb Electronics*** has appointed Bob Payne as its general manager, after a nine year career working for Racal Chubb.
- ***Ribern***, which supplies the Maxiprint re-inker, has moved from Burwood to 194A Rowe Street, Eastwood; phone (02) 874 1147.
- Pat Tapper has been appointed national audio products manager for the professional audio products division of ***Greater Union Village Technology***, which was formed out of the merger of Greater Union Theatre Supplies and Village Roadshow Technology. Gerry Nixon has been appointed as sales manager for NSW and Qld.
- ***Amber Technology*** is now the exclusive Australian distributor for the range of Fairlight digital audio and video products.
- The new marketing manager for ***Critec*** is Dr Tony Surtees, formerly senior projects manager R&D at Plessey SA. Victoria Henderson is now in charge of Critec corporate communications.
- ***Standards Australia*** recently published a new standard which concerns linearly polarised antennas for domestic use within the frequency range 30MHz to 1GHz. The AS 1417 is technically identical with IEC 597 Parts 1-4, except for the mechanical properties included in Part 1.
- ***Nilsen Instruments*** has signed an exclusive marketing agreement with Yokogawa Instruments of Japan. Yokogawa recently entered the electrical/electronic test equipment area with a state-of-the-art range of handheld instruments.
- The Hong Kong Association for the Advancement of Science and Technology has conferred an honorary fellowship on Thomas Yuen, co-founder and chief operating officer of the Californian-based AST Research. The award was in recognition for Mr Yuen's contribution to shaping the development and directions of PC technology.
- Mr Eric Wright (47) died recently in Sydney of cancer. He joined ***TDK*** in 1985 as national sales manager, having previously worked for CBS Records.

icons, dialog boxes, pop-up menus and high-speed graphics with familiar front panel knobs and buttons.

The TDS on-board digital signal processing functions include waveform pass/fail testing, fast signal averaging, waveform math and 22 automatic measurements.

The TDS user interface, based on extensive customer research, was designed by Tek's Oscilloscope Group in conjunction with Tek Labs, Tek's scientific research arm.

Its icon-driven menus, coupled with familiar front-panel knobs and buttons, enable users to learn and operate the new scopes more quickly and to gain substantial productivity increases from the start. And, if users need further explanation of any functions, a novel online Help Text facility is available at the press of a button.

Tek's TDS540 digitally acquires signals with a 500MHz bandwidth at a conversion rate up to 1GS/s, using four 8-bit A/D converters. The TDS520 acquires signals with 500MHz bandwidth at up to 500MS/s.

The A/D converters of both instruments also operate independently, simultaneously acquiring four signals at 250MS/s on the TDS540 or two signals at 250MS/s on the two-channel TDS520.

Both the TDS520 and 540 offer 1mV to 10V/division sensitivity. They incorporate the fast overdrive recovery, wide dynamic range, calibrated DC offset, and variable gain capabilities previously available only on Tek's 11000 Series lab scopes and DSA600 digitising signal analysers.

The TDS's novel acquisition system offers peak detect and a new high resolution (Hi-Res) mode. With 4ns peak detection, users can be confident of capturing glitches at even the slowest sweep speeds.

The Hi-Res mode increases the dynamic performance on signal shot events. The TDS platform uses a multiprocessor design incorporating a Motorola 68020, Tek's TriStar Digital Signal Processing IC (DSP), and a proprietary display processor.

IPC WORKSHOPS 'A GREAT SUCCESS'

The first workshops to be conducted in Australia by the Institute for Interconnecting and Packaging Electronic Circuits (IPC) in association with the Surface Mount and Circuit Board Association (SMCBA) proved to be very successful and, given the current economic climate, well attended.

Dieter Bergman, Technical Director and Happy Holden, Consultant to the IPC presented the two day workshops on Producibility of High Quality Printed Board Assemblies. Meetings for PCB Manufacturers and the IPC representatives were also held following the workshops in Sydney and Melbourne.

A limited number of workshop handbooks which include a number of IPC documents and standards, are available for purchase for $120 for SMCBA Members or $200 for Non Members.

KODAK UNVEILS 'PHOTO CD' SYSTEM

Kodak (Australasia) has demonstrated a new photographic system which scans 35mm images and transfers them to compact disc for home television display via a newly developed CD player.

A key element in the new system is a Photo CD player manufactured by Philips, which will give consumers both CD audio sound and high quality television display.

The system will become available in Australia in the second half of 1992, with the first multi-functioned Kodak Photo CD player expected to start at a list price under $1000. A disc of 24 images is expected to cost around $20. Each digitised picture will contain up to 18 megabytes of data — equivalent to the original 35mm negative from which it derived.

The Photo CD will be packaged in an attractive 'jewel case' similar to those containing audio CDs. The case will contain an index print cover sheet, with a grid that displays miniature pictures of the 100 images capable of being stored on the disc, each with a number showing its sequential position on the roll and on the disc.

Very high quality prints may be made directly from the Photo CDs with Kodak thermal printers. Colour, sharpness, and granularity are similar to those of prints made on photographic paper from original negatives. ■

Electrical safety:

CHOOSING THE RIGHT RCD

We have published quite a few articles and letters in recent months, highlighting the need for the form of protection offered by Residual Current Devices (RCDs). The author of this article works for Gerard Industries, an Australian manufacturer of the devices. He explains how RCDs work, and compares the advantages and disadvantages of the two main types available, to help you choose the one most suitable for a particular application.

by PETER FOLEY

There are many factors to consider when choosing RCDs for a particular installation. One needs to ensure that one is choosing a product of adequate quality to provide reliability and serviceability over a reasonable time scale.

One also needs to ensure that the design of the RCD installation is such as to provide a high level of protection, but a low likelihood of unwarranted tripping.

And lastly, one needs to ensure that the operating features of the RCD that you choose are appropriate for the individual requirements of the installation.

Different types of RCDs have different operating features which can sometimes be particularly relevant. So what are the different operational types? What are their advantages and disadvantages? What applications favour the different types?

Two main types

There are two main types of RCD — those that are electro- mechanical in operation and those that are electronic.

Both types use a toroidal transformer to monitor the protected circuit or circuits. All the load carrying conductors for the circuit pass through this toroid (Fig.1).

When a current imbalance occurs in these conductors, their vector sum ceases to be zero, and therefore the magnetic fields generated by the load current cease to be self-cancelling and a current is induced in the secondary winding of the toroid (Fig.2).

The important difference between the two types of RCDs is how they use that output to open the circuit. The electro-mechanical type uses it directly, while the electronic type uses it indirectly.

Electro-mechanical types

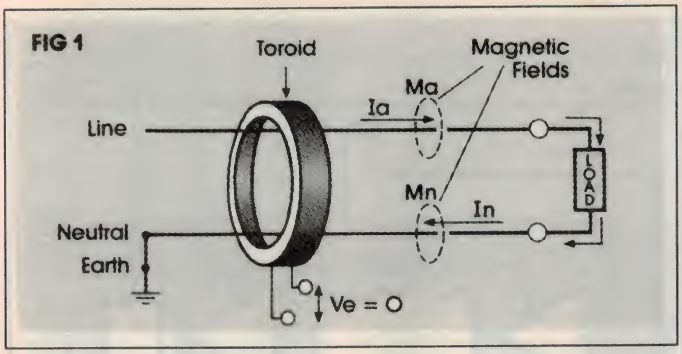
Electro-mechanical RCDs are essentially a magnetically held relay. They consist of a permanent magnet holding an armature pole piece in place against a tension spring, with either a polarised release winding or a saturation trip mechanism. In this latched condition the circuit is closed.

With the former, circuit opening is achieved by having a pole piece winding in series with a winding on a toroidal transformer.

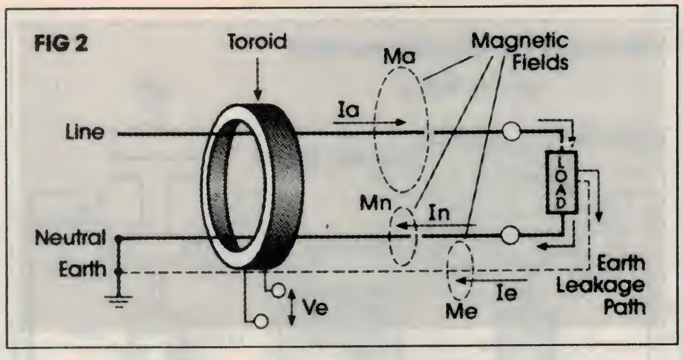
When a residual flux causes a current to flow in the winding on the pole piece, the flux generated around the pole piece either strengthens or weakens the field holding the armature in place (depending on the particular AC half cycle). When the field is sufficiently weakened, the armature is released and the circuit opens (Fig.3).

The drawback with this type of device is that they can only react quickly to faults in one half of the waveform. That is, unless a fault occurs early in the half cycle which *weakens* the field, disconnection might be delayed almost a full cycle.

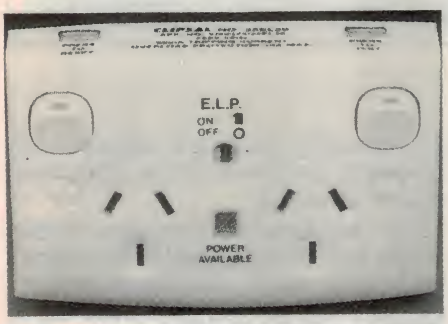
These days this basic polarised release mechanism is usually found in a more sophisticated form which has a centre-tapping in the toroid winding.



Normal operation.



Fault operation.



This electronically operated RCD replaces the first power point in a circuit. It provides protection for all other power points following it on that circuit.

This centre tap is connected to one side of the release winding, while the other side is connected, via diodes, to the start and finish of the toroid winding (Fig.4).

This system ensures that the polarity of any potential across the release winding is one that will weaken the field of the permanent magnet, and thus open the circuit.

These modifications enable it to respond to faults in both halves of the waveform and thus improve its reduction time significantly.

The alternative release mechanism is the saturation trip relay. This system again uses a permanent magnet holding a pole piece against a spring tension, but this time the permanent magnet flux must pass through two narrow regions in and around the toroid (Fig.5).

These are the saturation regions. As the name suggests, the magnetic material in these regions is already almost completely saturated by the existing permanent magnetic flux.

When an imbalance of current of either polarity occurs, the resulting flux subtracts from the permanent magnetic flux in one of the saturation regions, and tries to add to it in the other.

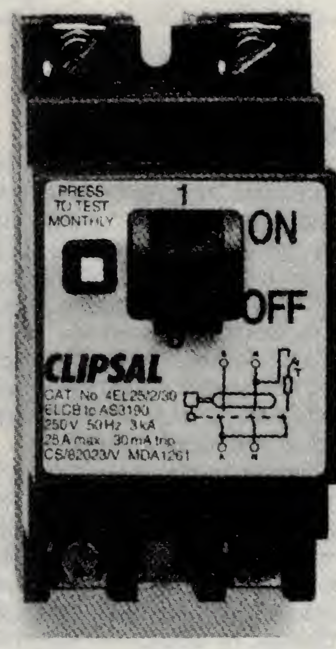
However, the saturation prevents any significant increase in this latter region, and so the nett effect is a decrease in the total flux holding the pole piece. This decrease releases the armature and opens the circuit.

Electronic types

Electronic RCDs all operate along very similar lines.

Again the fault currents are sensed by a toroidal transformer, but rather than having the toroid signal operating directly on the circuit opening mechanism, it merely becomes the input to an electronic circuit that decides whether or not it is necessary to open the circuit (Fig.6).

If the signal does fall within the tripping parameters, a shunt trip relay is energised which opens the circuit con-



A switchboard mounted electromechanical RCD. Using a magnetic saturation relay, it operates on both halves of the AC waveform.

tact mechanism. The only significant variation occurs in some portable devices which use an electrically held relay. If an appropriate fault is detected, the relay is shorted out by an SCR, thus opening the circuit.

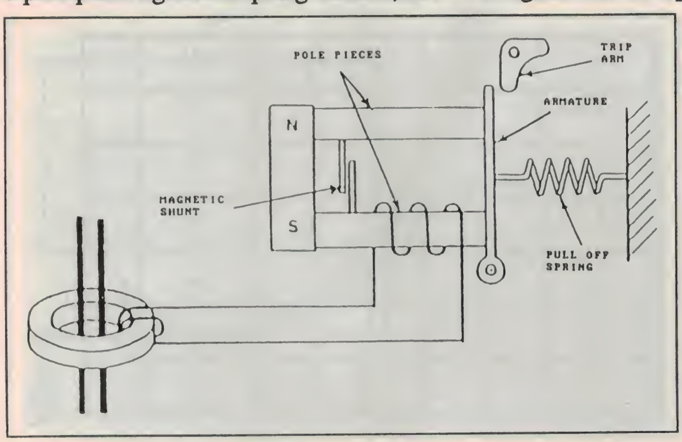


Fig.3: Polarised release winding.

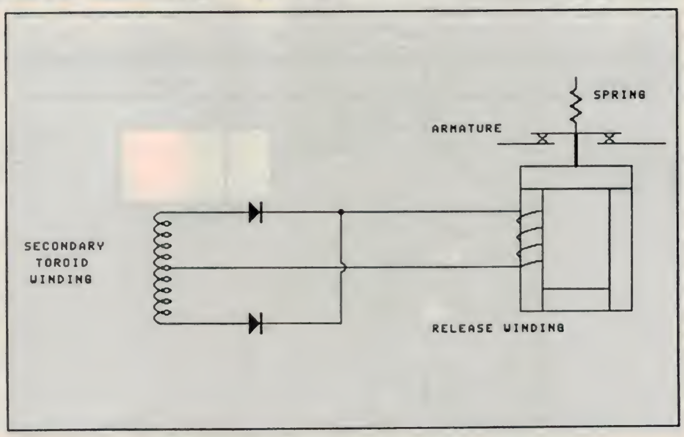


Fig.4: Centre tap polarised release mechanism.

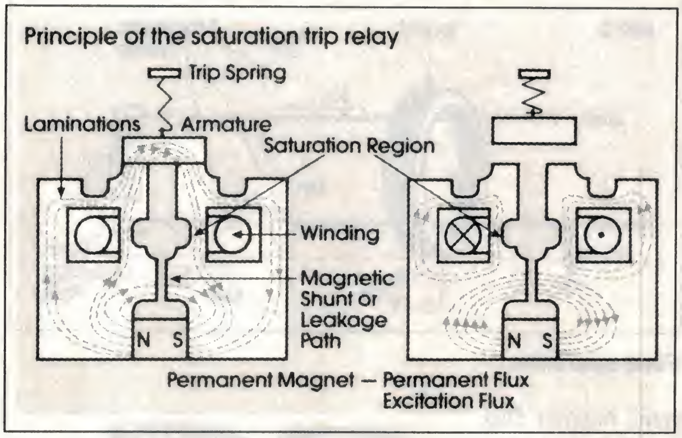


Fig.5.

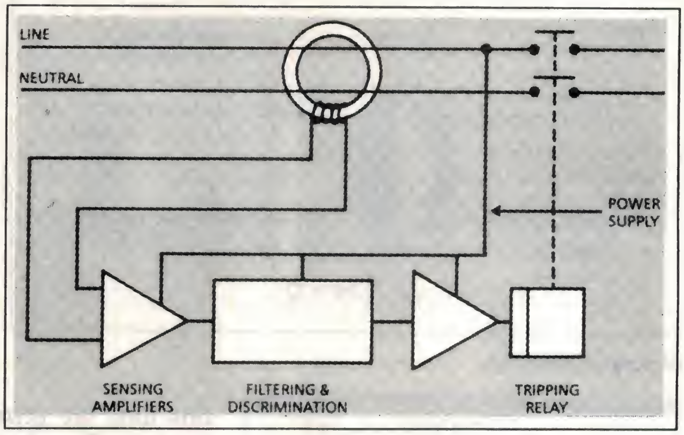


Fig.6.

Nuisance tripping

Both types of RCDs have protection against nuisance tripping by electronic noise, either by use of a 'tertiary coil filter' in the electromechanical RCD (Fig.7) or by filtering and 'noise blanking' in electronic models. Such noise is an electrical disturbance in the form of high voltage spikes for short periods of time, and is caused by switching reactive loads such as fluorescent lights and electric motors (Fig.8).

These circuits, however, do not protect against standing earth- leakage currents.

Many installations have a few milliamps of inherent residual current flow to earth — due to minor, undetected faults such as cable insulation deterioration or damage, or the entry of moisture, vermin or insects into areas with exposed terminals or fittings.

This usually poses no problem, unless there are several cumulative leakages. But any leakage makes the RCD more sensitive.

For example, if the earth leakage is 10mA, then a 30mA model RCD (whose normal tripping current is 25mA) will now trip on a 15mA fault. This could make it too sensitive.

Advantages and disadvantages

The advantages and disadvantages of each type are probably fairly obvious.

It is clear that the electro-mechanical devices, not being supply potential dependent, are likely to perform more dependably than electronic devices where the supply voltage is particularly unstable. However, because electromechanical devices are operating on such low energy factors, often as low as 200uVA, they need to be very finely tuned mechanisms. This leaves them more likely to be effected by jarring and vibration than their electronic equivalents.

And again because of the low energy factors involved, noise filtration and discrimination circuits cannot be as sophisticated as in electronic devices.

In electronic devices, the output from the toroid is amplified into a much more substantial signal. Therefore, far better filtering is possible. This makes them the preferred choice where some noise is likely to be present.

Similarly, this more substantial signal means that the mechanism itself can be much more robust and so less likely to be effected by jarring and vibration. Additionally, electronic devices often have a price advantage.

The only feature of electronic devices which may be considered to be a drawback is that, being power supply dependent, they will not operate if either leg of the supply is inadvertently disconnected. This would only present difficulties in an extreme set of circumstances.

Favoured applications

Generally speaking, electro-mechanical RCDs tend to be favoured for multi-circuit applications and applications where supply potential can be erratic.

Similarly, electronic types tend to be favoured for individual circuit protection and for applications where vibration and noise are a particular concern.

Ultimately, there is very little between the two types of devices in a majority of installation situations. One needs be careful not to put too much significance on this aspect, remembering that it is only the third level of consideration when choosing an RCD. The first two levels, namely reliability and a high level of protection, are likely to be far more significant to a satisfactory solution.■

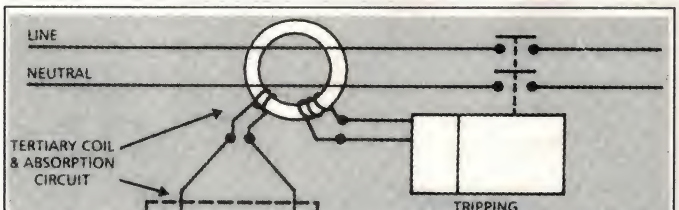


Fig.7.

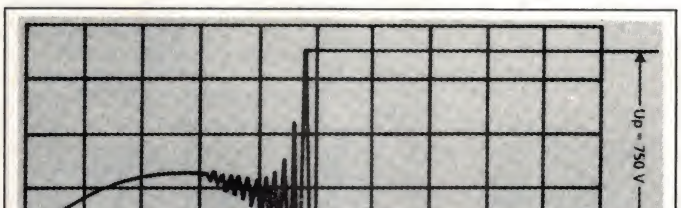


Fig.8.

PC-based Circuit Simulators - 3:

MICRO-CAP III, V3.05

The third main circuit simulator package currently available for use on personal computers is Micro-Cap III, from Spectrum Software. Here's a look at the functions and features provided by this package, in its latest Version 3.05.

by JIM ROWE

Having already discussed two previous simulator packages, along with at least the basic concepts of circuit simulation, I guess there's even less need for any preamble here than there was with the second of these articles. By this stage you're no doubt ready to hear about the third main package that's currently available: Spectrum Software's *Micro-Cap III*. The particular version we'll be looking at is Version 3.05.

Like the other packages we've looked at, *Micro-Cap III* is essentially based on the numerical circuit analysis algorithms developed at the Berkeley campus of the University of California, for its mainframe-based *SPICE2* simulator — which has become the international paradigm. But despite this common derivation, and also the fact that inevitably it's designed to carry out the same basic functions of functional circuit analysis, at the same time *Micro-Cap III* also differs quite a bit from both *PSPICE* and *IsSPICE*.

One difference that's immediately obvious is in the name itself, which unlike those of the others offers no immediate sign of any 'allegiance' to the original *SPICE2* or any derived standard. 'Micro-Cap' is in fact just a contraction of 'microcomputer-based circuit analysis package'.

As it happens, *Micro-Cap III* is at least partly compatible with SPICE-type simulators, to the extent that it comes with utility programs which can convert generic SPICE circuit library files for use by *Micro-Cap III*, and also convert both the latter's circuit files and model/device library files into generic SPICE files. This wasn't the case with earlier versions of *Micro-Cap*, I gather, but has been added to the latest version to allow users to take advantage of at least a proportion of the many device models which have been developed for SPICE simulators.

Spectrum's choice of a different name for its simulator seems to signify more than just a desire to differentiate it from the more obvious SPICE-derived packages. In a sense, it reflects the company's differing approach to simulator package design. Whereas the other firms seem to have placed at least their initial emphasis on the greatest possible compatibility with *SPICE2*, until now Spectrum has placed rather more emphasis on the ease and convenience of performing the basic task for which simulators are designed: creating a circuit model and running a simulation of the desired aspect of its operation.

This differing emphasis is revealed even more clearly by the package itself. Even the first 1982 version of *Micro-Cap* included a schematic capture editor, and also the ability to plot the simulation result dynamically during the run — both features that were well in advance of the first PC-based SPICE packages. The latest version *Micro-Cap III* is also far more 'integrated' and interactive than the direct SPICE-derived packages we've already looked at, with a full windowing graphics user interface that can be driven using a convenient (and efficient) mouse-keyboard combination.

Not surprisingly, such features have made the *Micro-Cap* family more popular than its SPICE-clone competitors, when it comes to engineers and circuit designers working in industrial or commercial R&D situations. Spectrum claims to have sold over 10,000 copies to date, with a lot of them going to large corporations in the USA.

But perhaps ironically, and despite this widely acknowledged greater ease of use, until recently the *Micro-Cap* products seem to have been a little *less* successful than their SPICE-clone competitors in the universities and colleges — which until now have been the main users of simulators, of course. And the reason for this seems be largely because in the academic world, conventional SPICE simulators have reigned supreme. If a simulator didn't offer full SPICE compatibility, many academics were apparently reluctant to use it — no matter how fast and friendly it might be.

So in a sense, Spectrum seems to have paid a price for putting user convenience ahead of SPICE compatibility, in the academic sector of the market — at least with the earlier versions of *Micro-Cap*. Presumably that's another reason why it added partial SPICE compatibility to *Micro-Cap III*, and is apparently making its next version (due late this year) fully *SPICE2G* compatible. More about this later.

Mind you, I would think that the big future for circuit simulators and related CAD software is more likely to be in the non-academic segment of the market, which has the potential to be much larger than the academic segment. And circuit designers outside the ivory towers of academe are generally more interested in having a design tool that is convenient and efficient to use, rather than placing great importance on compatibility with a rather elderly and unfriendly mainframe system. So Spectrum's continuing emphasis on user convenience should stand it in good stead, for the next and probably main phase of simulator market growth.

Some background

Spectrum Software is based in Sunnyvale, California, and was founded in early 1980. Initially it concentrated on software for Apple II computers, and came out with a 'circuit creation and simulation' package for digital logic circuits in June 1980. This was followed in August 1981 by a simple simulator for linear analog circuits.

The first of its *Micro-Cap* packages was released in September 1982, more than a year ahead of *PSPICE*. Although not a fully integrated package,

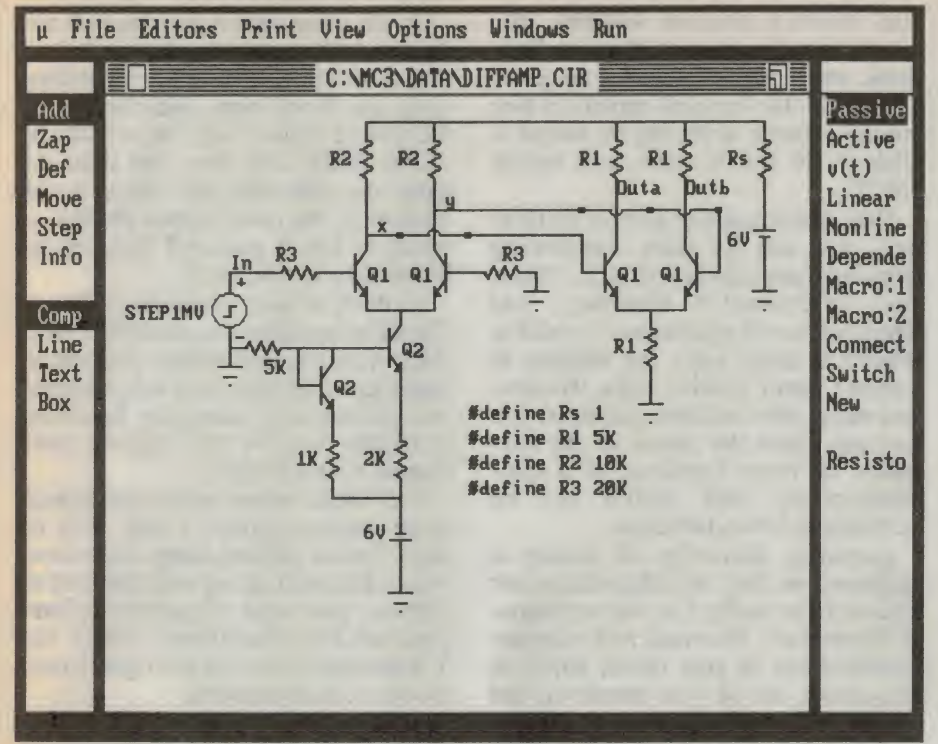


Fig.1: The main or 'homebase' screen of Micro-Cap III is the schematic editor, shown here with a sample schematic. The narrow side menu at left is to select editing modes, while that at right is used to select components and subcircuits.

as noted earlier it did include a schematic capture program to generate netlists for the simulator to analyse, and had the ability to plot results during the actual simulation rather than afterwards. It was produced in both Apple II and IBM PC versions.

Micro-Cap II appeared in November 1984, only 10 months after the appearance of *PSPICE*. This version offered an improved schematic editor and enhanced device models, and was gradually upgraded in later years to provide support for co-processors, high resolution video displays and plotters. There were versions of *Micro-Cap II* for both IBM-compatible and Apple Macintosh machines.

The current *Micro-Cap III* was released in December 1988, and was the first to provide a fully integrated, interactive package with mouse-driven windowing graphical user interface. It is only available for IBM-compatible machines. Since its introduction this version has been re-written in C language, and also enhanced with modelling for analog 'behavioural' sources (Laplace and nonlinear functions), nonlinear magnetic cores (based on the Jiles-Atherton state variable model), gallium-arsenide MESFETs (two levels), and op-amps (two levels). It also includes a choice of either the Ebers-Moll or Gummel-Poon models for bipolar junction transistors, three levels of modelling for MOSFET transistors, and models for simple switches; the ability to perform temperature stepping, parameter stepping and Monte Carlo analysis for each of the main analysis options; a Nyquist plotting facility for AC analysis results; a Fourier analysis facility for waveform files created during transient analysis (or indeed from a similar file produced by another package, or by a DSO); and the ability to save the final values from one transient analysis of a circuit model, and then use these as the initial conditions for another run.

Hardware needs, protection

The standard *Micro-Cap III* will apparently run on anything from an 8086-based PC/XT to a PS/2, with a version also available to take advantage of the 386 processor. However because of its integrated nature and graphical interface, the package does require a reasonable amount of memory; the standard version needs the full 640K of DOS base memory, while the 386 version also needs a minimum of 2MB of *extended* memory.

Spectrum notes in its manual for *Micro-Cap III* that the standard version needs at least 560K of available program memory (i.e., not taken by DOS or TSR's, etc), while 1MB of *expanded* (LIM EMS) memory is required if the package is to handle the largest simulations it's capable of tackling: apparently circuits of up to 500 components, and with an unlimited number of nodes.

Both versions will work with all main graphics adaptors, while the standard version will even work without a numeric co-processor — described as 'optional but highly recommended'. The co-processor is essential for the 386 version, but like the standard version this will run from high-density diskettes as an alternative to a hard disk. Both versions are able to automatically detect if your system has a co-processor and/or additional memory, and take advantage of these if they find them. Needless to say as with any other simulator, best results with either version will be achieved using at least a 286-based hard disk machine with a co-processor.

Other requirements are a Microsoft or compatible mouse, and DOS 3.2 or later. Both versions will drive either an Epson-compatible dot matrix printer or an HP Laserjet-compatible laser printer, and either an HP 7470/7475 or Houston Instruments compatible plotter.

It should be noted that *Micro-Cap III* is copy protected, using a scheme that allows two different kinds of installation on a hard disk system. One option is to have it installed together with a special hidden 'key' system file, generated during the installation process. This allows the package to be run in the normal fashion, but only two such 'running copies' can be installed from the master disks supplied. If you want to change machines or disk drives, the package must be 'de-installed' back onto the master disks, and then re-installed to the new machine or disk drive. The alternative option is to install the package so that it needs the master 'A' disk to be in the machine's floppy drive A as a key' disk, whenever you run *Micro-Cap III*. This option allows you to have the package installed on any number of machines, but only one can be in use at any particular time because of the need to use the master 'A' disk as the key.

What happens if you choose the former 'key file' option, and then have a hard disk crash which effectively zaps one of your installed copies? Or you accidentally reformat your disk, but forget to de-install *Micro-Cap* first? In cases like this of genuine loss of 'installation count', Spectrum will provide a free replacement.

The *Micro-Cap III* package can be supplied on a variety of floppy disk formats, as desired. Our review copy came on four 1.2MB 5.25" diskettes. Along with the main simulation package itself

there is an installation program and four utilities: *PEP*, a parameter estimation program to assist in providing model parameters from data sheets and measurements; *TOSPICE*, which generates *SPICE* circuit files from *Micro-Cap III* files; *CONVERTF*, which converts *circuit* files from earlier versions of *Micro-Cap*, for use with Version 3; and *CONVERTL*, which can convert *library* files from either earlier versions of *Micro-Cap*, or generic *SPICE* library files for use with Version 3.

Using Micro-Cap III

Although like many PC users I'm not entirely happy about having to leave a disk in the A drive, because of the risk of viral infection, I elected to install *Micro-Cap III* using the 'key disk' option. This allowed me to install it on both the 20MHz 386SX machine in the office, and on the 12MHz 286 machine at home, and try it repeatedly on both without having to risk losing either of the 'installation counts' on the master disks.

I especially wanted to do this because the 386SX machine has no co-processor, whereas at present I do have a (borrowed!) 80287 chip in the 286 machine. Since *Micro-Cap III* is capable of running on either, I wanted to compare the operating speeds on the two. This would also allow limited comparisons with the other two simulator packages previously reviewed. Installation turned out to be very straightforward, thanks to the special *INSTALL* program supplied. You simply fire this up and follow its directions, and in about 5 minutes the job is done. With the key-disk option it's then merely a matter of placing the master A diskette in the A drive, and typing 'MC3'.

Once you're running *Micro-Cap III* itself, you see its main windowing graphical user interface (Fig.1). This is not Microsoft's *Windows*, but Spectrum's own equivalent — which is similar in many ways, but different in various small details. Like *Windows* and many other modern packages, you can use either the mouse or the keyboard for many functions, or a combination of both which can be particularly fast and efficient.

Essentially *Micro-Cap III* package is organised so that the schematic editor screen shown in Fig.1 is your operational 'home base'. You create and make any modifications to your circuit model at this screen, set all your functional and control options using the pull-down menues along the top (together with various 'dialog box' windows they call up), and then use the 'Run' pull-down menu to call any of the available simulation options.

While the simulation run is taking place, a window overlays the schematic and the results are plotted dynamically in this window, as they're calculated. There's no waiting until 'after the run', and if it's apparent that the circuit isn't doing what you hoped, you can abort the run at any time and return to the schematic to make changes and try again.

On the other hand if all goes well and the run looks good, you can print it or plot it to get a hard copy, by pulling down the 'Print' menu and clicking on the desired option. You can actually do this at almost any time, and print out either the schematic, the 'front' screen window or the entire screen display — which is how I produced most of the illustrations in this article.

So that's a basic overview of *Micro-Cap III*'s operation; now for a little more detail. Creating and editing your circuit model using the schematic editor is quite straightforward, using the functions available via the two narrow side menues visible in Fig.1.

The 'Mode' menu on the left selects basic editing modes (Add, Zap or erase, Def or define/change definition, Move, Step etc), along with the kind of element you wish to address (Component/Line/-Text/Box), while the 'Component' menu on the right is used to select circuit elements.

Although the element symbols supplied with the package are to my mind a little crude, they can be modified or replaced using *Micro-Cap III*'s inbuilt 'shape editor'. However I found this a little tricky to use, especially when it came to modifying existing symbols rather than creating totally new ones. The symbols are basically created using vectors, but currently the package represents them on screen and prints them out using relatively coarse bit-map images. Only the plotter output appears to take advantage of the potentially higher resolution available from the vector rep-

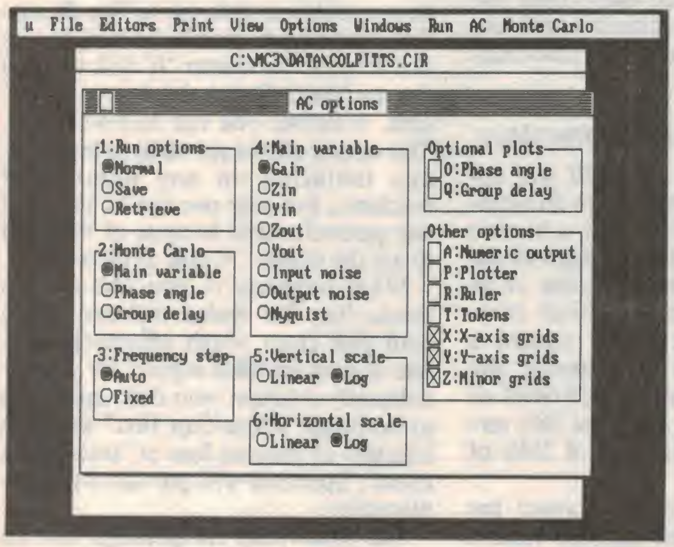


Fig.2: Here is the dialog box used to select options for AC analysis. Note the range of choices for the main variable, including Nyquist plot, and also the scaling options.

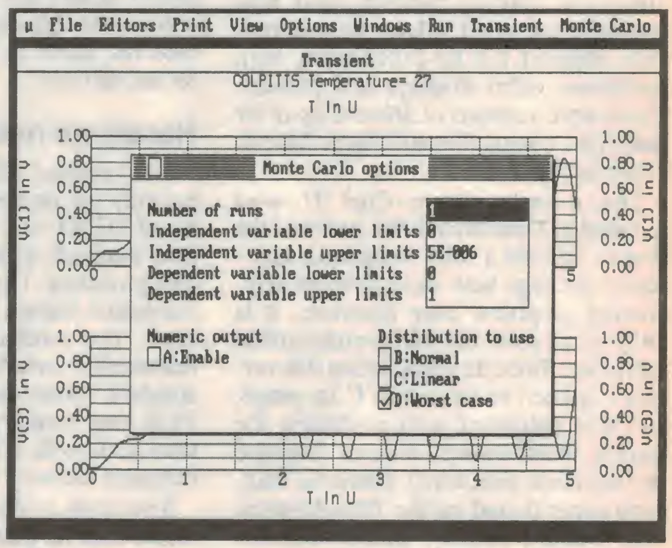


Fig.3: Here are the options available when you wish to run a Monte Carlo series — in this case, for transient analysis. Note the choice of normal, linear or worst case distributions.

resentation. More about this shortly. I found the right-hand component selector menu a little hard to get used to initially, because if you select the wrong element group it isn't clear how to 'escape' back to the main menu for a second try. In fact you have to select one of the items in the sub-menu, and this causes the main menu to re-appear with the selected item shown below (where 'Resisto' is visible in Fig.1).

You can't just 'bail out' by hitting the escape key, or clicking the mouse cursor on a 'cancel' button — in fact if you try doing these fairly intuitive actions, you're likely to produce unexpected and bewildering results, like your circuit and/or various screen windows disappearing!

Another little irritation is that the text 'labels' which accompany each component symbol can only be positioned in either of two fixed positions, for each orientation of the symbol. You can't move them relative to the symbol, as you can with many other schematic capture packages, and this means that the labels often tend to overlap each other (or other symbols and connection lines), unless you space them well apart.

I found this more of a problem once I started to run Monte Carlo analyses on some sample circuits, because in order to do this you have to specify not only the nominal value for each component, but also its tolerance. The added parameters made the labels even longer, and they began overlapping each other quite messily unless I *really* spaced everything out!

I did discover later that the designers of *Micro-Cap II* have provided a way around this one, however. The package allows you simply to label each component R1, C2, D7 and so on, and then provide all of the parameter values for each one using a series of '#Define' text statements below the schematic. This is actually illustrated in Fig.1, if you look closely. Still, it would be a little simpler and less fiddly if you could move the labels relative to the symbols...

A more serious criticism I'd make of the schematic editor is that it provides very little in the way of helpful prompting, when you are adding components to a circuit and it wants you to provide their parameter values. In many cases, once you've placed the component symbol on the schematic, it merely opens a totally blank little window, and just waits for you to enter the appropriate values — once you've worked out what parameters it's expecting, and the order it needs them to be in.

For simple passive components like resistors and capacitors this is not too bad, but for many of the fancier ones you're virtually forced to look up the device model data in the user manual, and work out what's to be keyed in. This is really not nearly as helpful as the *SPICENet* editor in *IsSPICE*, which almost always offers a helpful prompt line showing the format and syntax of the data it expects for the component concerned...

Still, I must admit that once you get used to this and a few other little areas where its friendliness could be improved, the editor is reasonably easy to use. More importantly, *Micro-Cap III* is really very helpful when it comes to calling up the simulation you want to run, setting up the limits and analysis options, indicating which circuit variables you want to monitor, what you want to do with the simulation results, and so on.

These things are basically all done with pull-down menues, some of which are shown in Figs.2, 3, 4 and 5 to illustrate the kind of facilites that are available and how easily they're accessed.

With simple circuits you can often run a simulation with little more than a click on the desired analysis type in the Run menu, and then a quick press of the F2 key to start the run. That's because *Micro-Cap III* seems to have the ability to 'guess' the appropriate analysis limits, and even the likely parameter of interest — quite apart from its ability to 'remember' the limits and options you last used on a simulation of the circuit concerned, and use these as the defaults for a new run.

All of this is very helpful, and can speed things up considerably when you're doing repeated component changes and runs, trying to find out the right values to get a circuit model to perform correctly. But until you get the hang of things, you can be easily misled.

When I first fed in my little 'benchmark' active LP filter circuit, for example, I called for an AC simulation to plot the frequency response. The frequency limits suggested by *Micro-Cap*

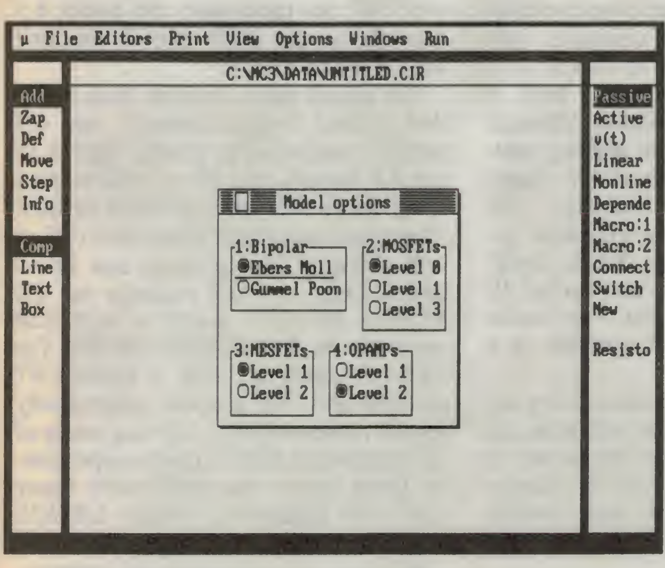


Fig.4: In a general sense, Micro-Cap III offers these choices of modelling for bipolar transistors, MOSFETs, MESFETs, and op-amps.

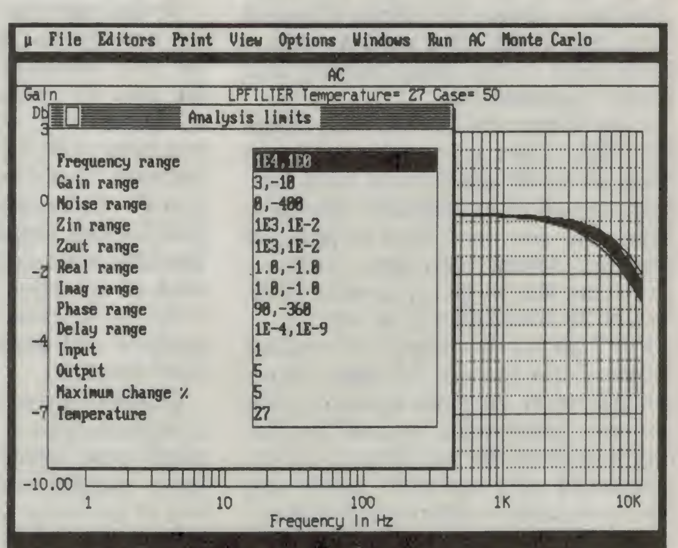


Fig.5: For each kind of analysis, Micro-Cap III allows you to set the analysis limits and related parameters using this kind of dialog box.

Micro-Cap III

III were way too high, so I changed these to cover the audio range of interest. But when I ran a simulation, there was no evidence whatever of any high-end rolloff — just the low-end rolloff due to the input coupling components.

Hmmm... what could be wrong? I knew the circuit *did* start rolling off at about 2kHz, because it was exactly the same one that I'd used with both *PSPICE* and *IsSPICE*. Why wasn't it working here? Then it suddenly occurred to me. I hadn't actually told *Micro-Cap III* which circuit node was my output — i.e., which node voltage was to be taken as the output variable, in working out the circuit gain. Somehow I'd assumed that being so 'smart', it had worked that out for itself...

Needless to say, it turned out to have 'guessed' that node 2 was the output, and node 2 was merely the other side of the input coupling capacitor. Hence the lack of any rolloff! As soon as I called up the AC analysis limits dialog box, and changed the output node to 5, everything went as expected — and not just for that run, but for all further runs on the same circuit.

Fig.6 shows a printout of the complete screen after a 50-case Monte Carlo run on the LP filter, for comparison with the results from previous simulators. Note that it shows both the circuit's gain in dB and phase shift in degrees, with only the top-cut components allowed to vary during the Monte Carlo run.

The others were fixed at their nominal values, to provide a direct comparison with the runs done on previous simulators. Seeing the effects of spread variations in the other parts as well is easily done — you simply specify their tolerance parameters...

I should note that the AC analysis option also allows you to plot the group delay curve for the selected main variable, as well as its amplitude and phase shift. And you don't have to print the complete screen each time, either — I've done that to give you more of an idea of the screen display as well.

Fig.7 shows the results of another Monte Carlo run on the same circuit, printed out in the more usual way. For this one I selected the 'normal' distribution instead of the 'worst case' one for component value variations, by the way, which explains its different appearance.

By the way, I didn't have any problem here with 'wrong connections' to the power supply pins of the 741 op-amp, because *Micro-Cap III* doesn't even provide its op-amps with power supply pins

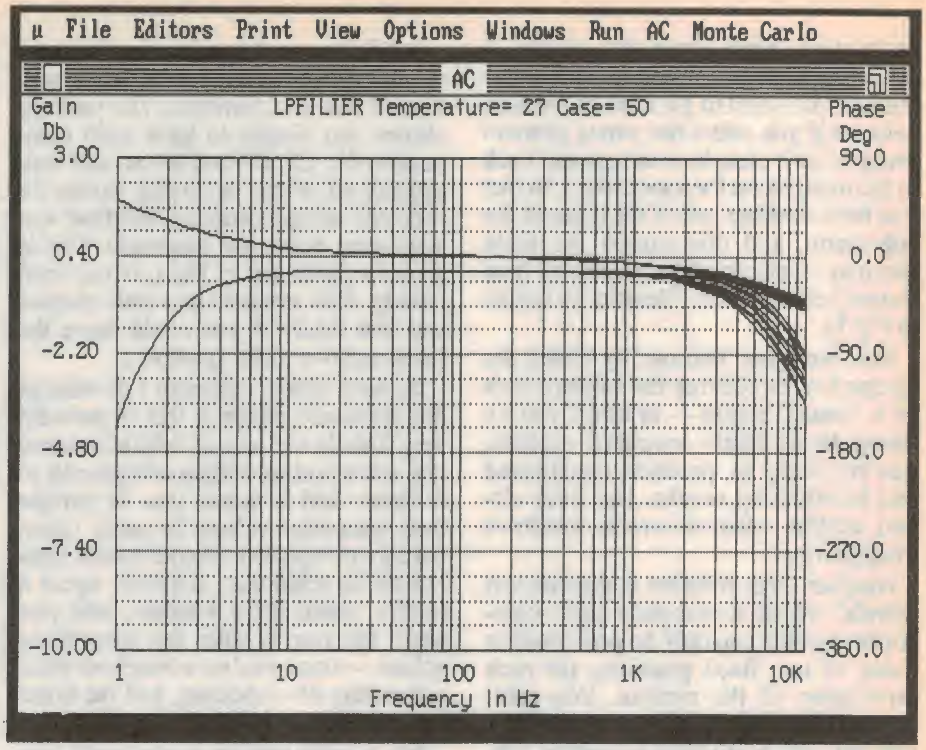


Fig.6: Here is the plot for the frequency and phase response of my little low-pass filter circuit, as produced by Micro-Cap III after a Monte Carlo run of 50 paces. This is also how it looks if you select the 'print entire screen' option.

to connect to. It seems to 'assume' correct connections to an appropriate power supply, which as far as I can work out is built into the actual device model and fixed at +/-15V. You *might* be able to vary this, to see the effects of running a device from lower supply rails etc., but as yet I haven't been able to work out how this could be done. It's one of the many little areas where the manual isn't very forthcoming...

By this stage you're no doubt wondering how *Micro-Cap III* compares with the other simulators we've looked at in the area of operating speed. Well, it compares very well indeed, although you have to be careful in making comparisons. That's because of the operational differences between the SPICE-clone simulators, with their essentially non-interactive 'batch mode' kind of operation, and *Micro-Cap III* with its interactive but 'one main analysis and dependent variable at a time' operation.

Certainly if you only want to carry out a single analysis at a time, and look at a single main variable, the comparison is fairly straightforward. And in practice this is probably the way most people will use a simulator, so it's a reasonable basis of comparison.

But if you want to make a number of different analyses and/or look at a number of different variables, it becomes harder. With the SPICE-clone simulators you can do all of the analysis in a single composite run, whereas with *Micro-Cap III* (as far as I can determine) you have to do separate individual runs...

Still, it is possible to make reasonably valid comparisons. With *Micro-Cap III* a single 'DC operating point plus AC analysis' run on my little active LP filter circuit took only a little over a second on the 12MHz 286 machine with 287 co- processor, and about 5.5 seconds on the 20Hz 386SX machine without co-processor.

The output noise analysis took a further second (approximately) and 4.5 seconds respectively, giving figures of say 2.5 seconds and 10 seconds respectively for an analysis equivalent to those I had done with *PSPICE* and IsSPICE.

Similarly a Monte Carlo run of 50 cases took only 65 seconds on the 12MHz 286/287 machine and 220 seconds on the 20MHz 386SX for DC+AC analysis, with a further 47 seconds and 140 seconds respectively for the noise analysis — giving totals of 112 seconds and 360 seconds respectively. These figures are significantly faster than those achieved for either *IsSPICE* or *PSPICE*, it must be admitted.

Whether the same order of improvement applies with larger and more complex circuits, or with transient analysis as opposed to AC analysis, remains to be

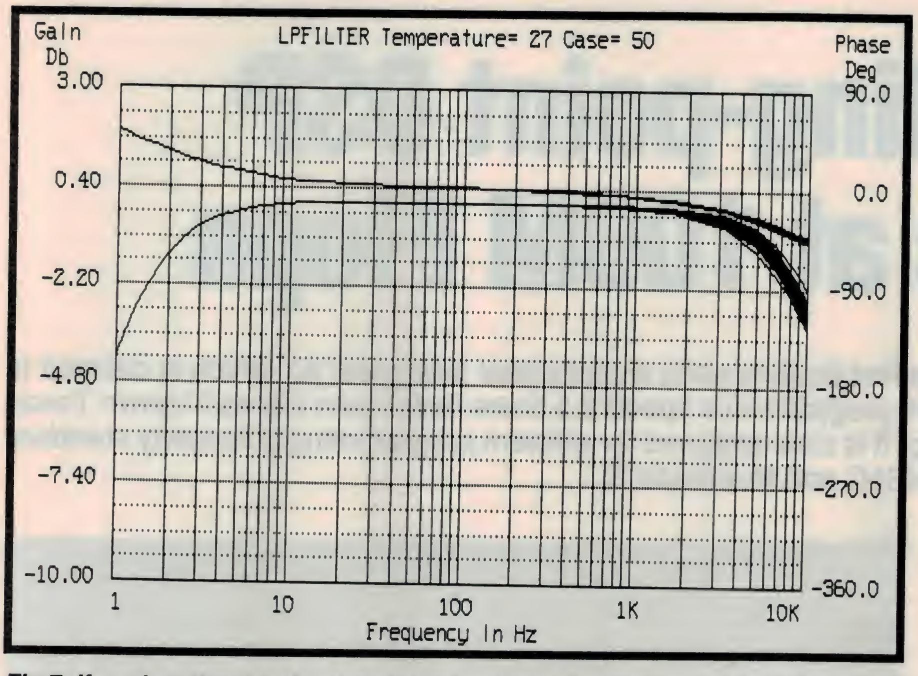


Fig.7: If on the other hand you select the option of printing out only the analysis plot, this is the kind of output you get. It's reproduced here at 55% of the size produced on an HP-compatible laser printer.

seen. I've also seen a suggestion that *Micro-Cap III*'s noise analysis doesn't take op-amp noise into consideration, which if true would presumably mean that its noise analysis sacrifices accuracy for speed...

My impression, based on some transient analysis runs of both some of the sample circuits supplied with *Micro-Cap III* and a few I cooked up of my own, is that it's not significantly faster than *IsSPICE* or *PSPICE* for this kind of analysis. It took about five minutes to do a single transient analysis run on a simple two-transistor RC oscillator on the 12MHz 286/287 machine, for example, and just on seven minutes to do a similar run on an even simpler one-transistor Hartley oscillator, on the 20MHz 386SX machine.

Still, there's no doubt that *Micro-Cap III* stacks up very well indeed in the speed department, both compared with the SPICE packages and in terms of using it as a design tool.

Summary

In general, from my experience with *Micro-Cap III* so far, I'd have to give it top marks for ease and efficiency of use. Its integrated interactive operation and graphical user interface really make it rather easier and quicker to use compared with the current versions of the other packages.

As noted above its actual simulation speed is very impressive too. There are of course those little unfriendly aspects of the schematic editor, which I'd like to see improved. By the way there is an online context-sensitive help facility, although this isn't always available — and generally seems to be 'not there' when you need it most (Murphy's Law!).

I'm also rather disappointed in the resolution available from the printouts. Even on a 300dpi laser printer, *Micro-Cap III* only prints out at a fairly coarse resolution of about 50dpi — virtually the same as on an 8-pin dot matrix type (I tried both). This is pretty mediocre in comparison with the printing options and much higher resolution available from either *PSPICE*'s *PROBE.EXE*, or *IsSPICE*'s *IntuSCOPE* programs. This is all a bit puzzling, because *Micro-Cap III* actually seems to create and store at least the schematics in vector form. You'd think it would be relatively easy to give it the ability to spit out a Postscript file, or higher-res bit mapped images...

There doesn't seem to be any facility to port schematics, plots and waveforms over into other software packages as graphics files, either — at least as far as I could find.

My final niggle about *Micro-Cap III* is in regard to its user manual. This is nicely presented, and generally well organised. But in many areas it's surprisingly short on helpful information about the package's capabilities, and there are an annoying number of areas where you're simply fobbed off with a suggestion that for more information, you should refer to chapter X of reference paper or book Y.

A case in point is the 31-odd sample circuits that are included with the package, presumably to illustrate various points about the package's functions and facilities. There's virtually no explanatory text about most of these in the manual; all you get is a reproduction of their schematics, which in some cases have a sentence or two of explanatory 'comment' text on them. You're really on your own, having to load each one and work out for yourself what aspects of *Micro-Cap III*'s operation it illustrates.

Hopefully Spectrum can provide a bit more helpful information in this and other areas of the manual, with future updates of the package. And talking of future updates, I gather that a significantly upgraded *Micro-Cap IV* is due to be released before the end of the year. This is predicted to have a much improved schematic editor, the ability to read and analyse *SPICE 2G* files directly, three levels of op-amp modelling and the ability to use the mouse cursor as a 'software scope test probe'. It will apparently be available in a Macintosh version as well as 286 and 386/486 IBM-compatible versions.

By the way Spectrum has a policy of allowing users to upgrade to the latest version for only the differential cost, so if you were to buy *Micro-Cap III*, you'd be able to upgrade to the new version for only the difference in price. The same arrangement applies with upgrading from evaluation versions to full versions.

And now that we're talking about cost, the current price of the full version of *Micro-Cap III* is \$1850 — a little more than *IsSPICE*, but well below *PSPICE*. An evaluation version is available for only \$200. The earlier *Micro-Cap II* is also still available, for \$1100, or in its own evaluation version for only \$130. Taking everything into account, then, and including price, *Micro-Cap III* should certainly be given very serious consideration if you're planning to get into simulation. Despite my criticisms, it has many excellent features — not the least of which are user convenience and speed.

Further information on *Micro-Cap III* or *Micro-Cap II* is available from local distributor David Spalding, of 45a Blackett Drive, Castle Hill 2154; phone (02) 639 3507. My thanks to David for providing the copy of *Micro-Cap III* for review, and for his help in getting answers to some of my questions about the package. ■

New floating-point DSP chip runs at 100M Flops

Analog Devices has produced its first floating-point digital signal processor IC, which is claimed to run commonly-quoted benchmark programs at a speed 2.5 times faster than the well known Texas Instruments TMS320C30-40 chip. It is also designed for efficient programming in industry standard high-level languages such as ANSI C and Numerical C.

The new ADSP-21020 is Analog Devices' first floating-point DSP processor, the end product of an evolutionary process that began in 1980 when company founder Ray Stata and his staff decided to enter the digital signal processing market.

The company released its first CMOS fixed-point DSP building block components in 1983, its first DSP microprocessor the ADSP-2100 in 1986, and its first single chip DSP microcomputer the ADSP-2101 in 1988. Last year it announced several derivatives of the ADSP-2101, including a low-cost 10MIPS version with half the memory and only one serial port.

Destined to become the first of a family of single chip floating-point DSP processors, the new ADSP-21020 was announced earlier this year at ICASSP 1991. Samples have been made available to applications developers since December, and already the new chip is being designed into applications for medical imaging, image processing and recognition, graphics, speech coding and recognition, radar, sonar and satellite imaging.

Having worked for some years with customers building custom solutions for DSP, Analog Devices identified what it calls the five key architectural requirements for any digital signal processing task:

1. Fast and flexible arithmetic units.
2. Extended precision and dynamic range through the arithmetic units.
3. Unconstrained data paths into and out of the arithmetic units.
4. DSP optimised program sequencing, including zero overhead looping.
5. Dual data address generation units with DSP addressing capability.

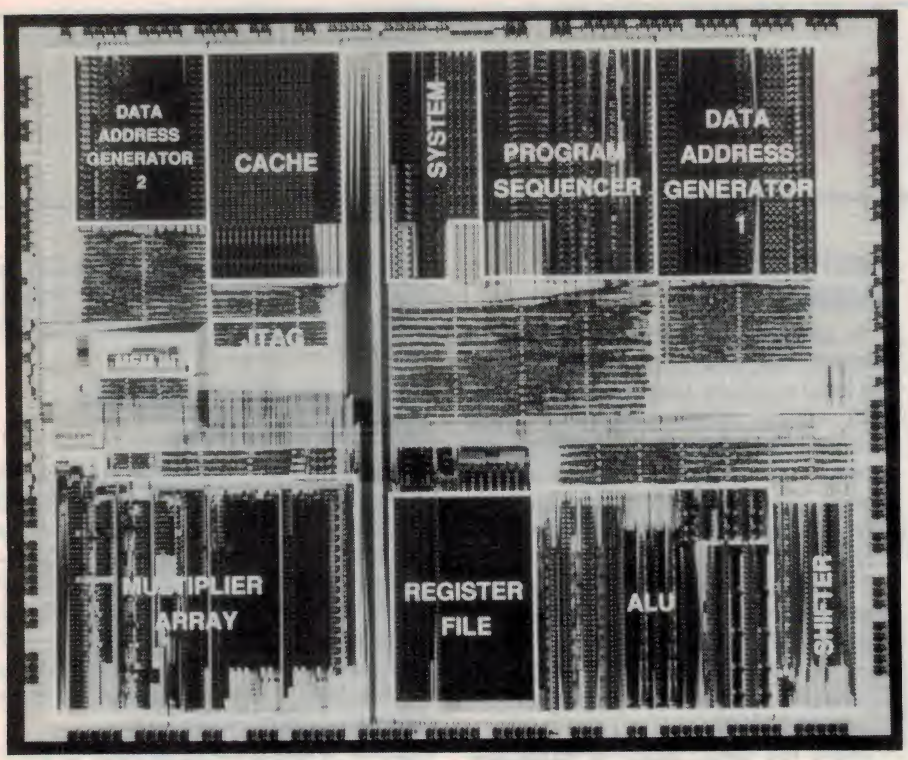
The ADSP-2100 was apparently the first production chip to meet all five of these requirements. The new

ADSP-21020 is claimed to go even further providing:

A. A richer instruction set and a data register file.
B. 32- and 40-bit IEEE floating-point and 32-bit fixed-point with 80-bit accumulation.
C. An eight-port register file to maximise internal and external data flow.
D. Program sequencing including delayed and non-delayed branching and interrupt on exception.
E. Data address generation with pre- and post-modify pointer up date and unrestricted circular buffer placement.

In addition, the architecture of the new chip is also designed to address the additional requirements of high-level language and operating system support; system diagnostics through JTAG serial-scan and on-chip emulation; and future digital and mixed-signal integration.

As a result, the ADSP-21020 proces-



A much magnified view of the ADSP-21020 floating-point processor chip, with the various functional areas identified. The new chip is claimed to run 2.5 times faster than the well known Texas Instruments' TMS320C30-40.

sor is said to be the industry's first device with architecture fully optimised for both signal processing algorithms and execution of code written in high-level languages such as ANSI C and Numerical C.

At the same time, the -100 grade version of the device typically delivers twice the speed performance of the current market leader, for the same process technology and using commonly quoted industry benchmarks.

Analog Devices describes it as achieving a speed of 100 'C30 equivalent' MFLOPS (million floating-point operations per second). Here 'C30 equivalent MFLOPS' is specified as a normalised figure, taken using the ratio of its speed against that of a Texas Instruments TMS320C30-40 device (which is specified at 40MFLOPS), when calculating a 1024-point complex FFT.

Execution of an arithmetic operation takes only a single 40ns machine cycle on the -100 grade chip. The common 1024-point complex FFT benchmark executes in only 0.77ms.

The ADSP-21020's compatibility with industry standard high-level languages such as ANSI C and Numerical C allows designers to efficiently code signal algorithms, which are critical in mixed-signal applications.

The ability to use high-level languages also reduces project development time, as well as making programming easier and code more portable. ANSI Numerical C is a draft standard superset of standard C, which includes extensions for vector and matrix operations — the basis of signal and numerical processing algorithms.

Software tools available for use with the ADSP-21020 include ANSI C and Numerical C compilers, an assembler, linker and simulator, plus a C-callable library and C-language source level debugger. Hardware tools include a low cost real-time emulator and a prototyping Lab Board incorporating ADSP-21020 with 32K of program and data memory, A-D and D-A converters, and RS-232C port.

The ADSP-21020 is also supported with tools from third-party vendors such as Spectron Microsystems (SPOX DSP real-time operating system) and Loughborough Sound Images/Spectrum Signal Processing, which can supply an IBM-PC development board with Windows 3.0 debug monitor and up to 640K program and data memory.

For further information on the Analog Devices ADSP-21020 processor circle 201 on the reader service coupon or contact Australian distributor NSD Australia, 205 Middleborough Road, Box Hill 3128; phone (03) 890 0970. ■

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NEW PRODUCTS

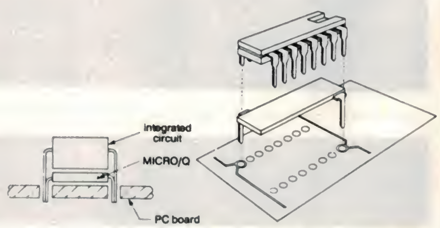
Decoupling cap fits under ICs

A decoupling capacitor which saves space because it fits under dual-in-line packages (DIPs) is now available in Australia.

Called Micro/Q 1000 capcitors, the devices are ideal for use in computers and computer peripherals, work stations, office products, as well as in industrial and telecommunication applications.

They reduce integrated circuit noise, and control EMI/RFI by reducing the inductance and impedance associated with conventional capacitors.

The capacitors increase board density because they reside under the IC package. They can also be retrofitted with no board design to solve problems in existing products.



Two sizes are available, one of which fits under 14 to 28 pin ICs, while the other fits under 24 to 48 pin chips.

For more information circle 201 on the reader services coupon or contact Soanar, PO Box 181, Lilydale 3140; phone (03) 727-8777.

Ten year battery

Modern micro-electronics now have a clear pace setter where high capacity lithium cells are concerned — the Varta CR cylindrical cell, specially developed for the specific demands of the computer age.

Laser welding and a self-discharge of less than 1% means that Varta lithium cells achieve a lifetime of ten years. They can be wave-soldered without any additional precautions. Their capacities vary from 2.0Ah for the AA, to 350mAh for the 1/4AA, the smallest type in the range.

For more information, circle 202 on the reader services coupon, or contact Adeal, 150 Bruckhurst Street, South Melbourne 3205; phone (03) 690 4911.

Mechanically polarised tantalum caps

In addition to their radial capacitors, Siemens Matsushita is now manufacturing axial tantalum electrolyitc capacitors with reverse polarity protection, which ensures they cannot be inserted the wrong way round in printed circuit boards. The protection is provided by a flattening operation on the positive lead on the capacitor.

The diameter of the positive lead has been increased from 0.7 to 1.0mm. If there are corresponding holes of various sizes in the printed circuit board, it is impossible to insert the capacitor the wrong way round.

There are three series of axial tantalum electrolytic capacitors ranging from 0.1uF to 1000uF, incorporating this innovation.

For more information, circle 203 on the reader services coupon, or contact Siemens Components, 544 Church Street, Richmond 3121; phone (03) 420 7716.

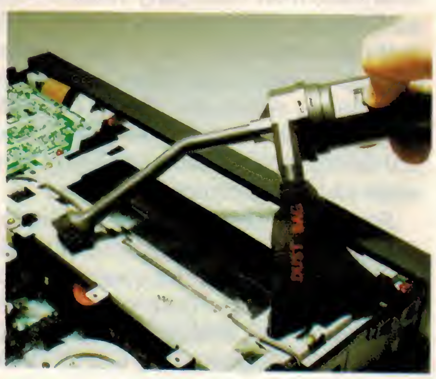
Mini vacuum cleaner

Scope Laboratories has released a cordless vacuum cleaner only 125mm high, which can also act as an air blower.

It is supplied in kit form and includes dust bag, angled extension piece, mini brush head and a 10 x 4mm slotted head for internal crevices.

Whilst aimed principally at service technicians in the camcorder, VCR and tape-recorder field, its compactness should also attract the attention of service people in camera, office equipment and textile machine fields.

It is powered by 4 x AA alkaline cells, which are not supplied at standard.



For further information, circle 204 on the reader services coupon or contact Scope Laboratories, PO Box 63, Niddrie 3042; phone (03) 338 1566.

Programming adaptors for flash memory

Programming adaptors for Intel's recently released TSOP (Thin Small Outline Package) Flash Memory chips are now available from Emulation Technology. Engineers designing with TSOP Flash Memory chips are now able to program the chips with their DIP programmers, using Emulation Technology's latest addition to their Adapt-A-Socket product line.

TSOP is the latest generation of plastic, surface mount, memory packaging from Intel. It provides engineers with an unprecendented level of nonvolatile memory bits for space constrained applications. The high-density, compact packaging of this high-performance chip increases the speed for a quick and reliable socket adaptor.

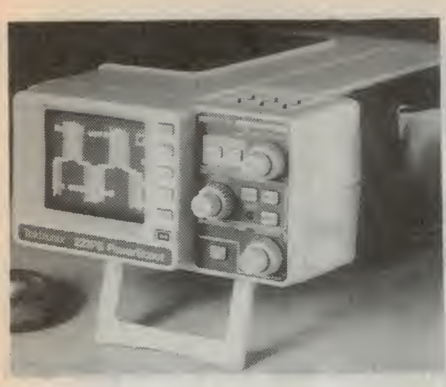
For more information, circle 205 on the reader services coupon or contact PP Components, PO Box 580, Bayswater 3153; phone (03) 764 5199.

Rugged portable DSO

Tektronix has announced the 222 PowerScout (222PS) — a rugged 10MHz bandwidth (10MS/s) hand-held digital oscillosope designed to make measurements safely on industrial power systems. The 222PS is the first oscilloscope to be UL listed for measurements on line voltages to 600VAC and is specified to withstand peak surge voltages as high as 6kV.

In situations such as three phase line-to-line measurements, where the input common has to be floated, the common 222PS input channel may be independently elevated to 600VAC above the instrument chassis. In the past, operators used isolation transformers in order to float their instruments for these measurements. Now they can forget about that live 480V scope chassis next to them and concentrate on the glitches they're trying to find.

Because the PowerScout's two channels are both independent and isolated, the operator is free to make measure-



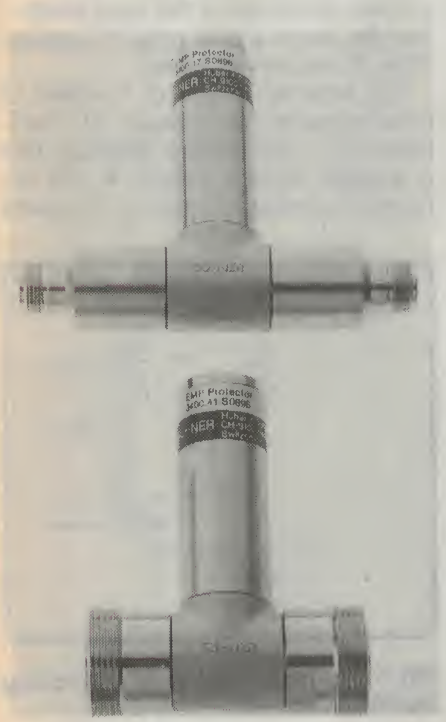
ments with the scope as he or she would be with a volt meter. One probe might be hooked up to 5V and the other to 480V with confidence in the safety of the instrument. The live display of the scope and give the user much more information about the incoming signal than would a volt meter.

The 222PS PowerScout shares the many ease of use and PC compatibility features of the 222, including autoset and autolevel trigger. It is also 100% programmable via an RS-232-C port.

For more information, circle 206 on the reader services coupon or contact Tektronix Australia, 80 Waterloo Road, North Ryde 2113; phone (02) 888 7066.

Cellular radio lightning protector

Huber + Suhner has recently designed a new lightning protector specially designed for cellular radio base stations which transmit and receive in the frequency range 797MHz to 1016MHz.



The protector is principally an in-line quarter wave shorting stub, with impedance matching 50 ohms.

Completely waterproof for outdoor installations, it is easy to mount using simple brackets or clamps.

For more information, circle 207 on the reader services coupon, or contact Huber + Suhner Australia, PO Box 372, Narrabeen 2101; phone (02) 913 1544.

Prototyping board

The latest product from BICC-Vero supporting the increasingly popular VXIbus is a 'C' size (6U x 340mm), eight layer, fully loaded, high density wire wrap prototyping board, fitted with socketed pins to aid device insertion and includes an on-board full VME bus interface based on the VTC-068 chip.

The 63-303103A board has been designed so as to give the user the maximum possible area of board real estate for prototyping.

The interface circuitry takes up only 12.4% of the area, and is also laid out so as to give maximum versatility in device selection.

In accordance with the VXI specification revision, 1.3, +5V, -2V, -5.2V and ground are taken from the appropriate pins on the P1 and P2 connectors, and distributed evenly across the entire board area via dedicated layers.

All voltage plans and ground can be accessed at specified points across the board using wire wrap pins.

Also across the board are surface mount decoupling capacitors which provide distributed coupling of the power rails and charge storage at the point of demand.

For further information, circle 208 on the reader services coupon or contact IRH Components, 32 Parramatta Road, Lidcombe 2141; phone (02) 748 4066.

Sealed Telswitch

Davidson has announced the release of a new silicone-rubber booted 16 position Panelswitch line from Planar Products.

The Hi-Rel Telswitchfeatures high reliability in a completely sealed, one piece silicone boot. The switch features positive snap action tactile feel, with contacts made from gold-plate etched copper circuitry.

The legend keys are securely fixed, but easily removed. The silicone boot is made from a special material which resists solvents, oils and many other chemicals, plus heat, ultraviolet radiation and scratching.

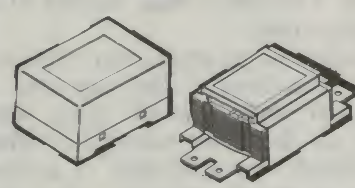
Output circuit connections are made to eight plated pins, at the back of the switch. The switch contacts are in an X-Y matrix configuration with a contact resistance of 0.5 ohms or less and are RFI/EMI shielded against radiation through the front of the keyboard.

For further information, circle 209 on the reader services coupon or contact Davidson Pty Ltd, 17 Roberna Street, Moorabbin 3189; phone (03) 555 7277.

PCB mount, low profile transformers

The standard range of compact 5VA and 7.5VA rated PCB-mount power transformers, with popular secondary voltage figures, is now available from Sydney-based Universal Electronics.

Both sizes measure 53 x 40 x 36mm, and are compatible with 2.5mm PCB grid spacing. Each transformer has two separate secondary windings, which can be connected in either series or parallel as required. There are nine models in both the 5VA and 7.5VA ranges, with secondary voltages of 4.5 + 4.5, 6 + 6, 7.5 + 7.5, 9 + 9, 12 + 12, 15 + 15, 18 + 18, 20 + 20 and 24 + 24.



Universal can also supply the popular low profile 'ballast' style transformers, in sizes with ratings of 20VA, 40VA and 60VA. These also have two secondaries which may be connected in either series or parallel, and are available in the same range of voltage as above.

For further information circle 210 on the reader services coupon or contact Universal Electronics, 9 Chard Road, Brookvale 2100; phone (02) 938 6804. ■

Secrets of simple DC-DC converters - 1

DC-DC power converters which use the blocking oscillator principle are very simple and cost-effective, but their operating principles are not generally well known. Now you can find out how they work, and start using these clever little devices to 'tailor-make' your own supplies with just a handful of components! This three-part series will cover the necessary circuit theory in Part 1 and give a simplified design procedure in Part 2. In Part 3, practical circuit designs will be discussed.

by ANDREW PIERSON

When the term 'DC-DC converter' is used, most electronics enthusiasts will think of the conventional push-pull type where a pair of alternately conducting transistors drive the centre-tapped primary of an inverter transformer. This configuration is widely used because the design procedure is straightforward and high power levels may be achieved with good efficiency figures.

However, a converter of this type requires a fairly complex transformer which is expensive to manufacture. Also, the circuit uses a minimum of two transistors, and consequently some designers have sought to use a simpler arrangement – the blocking oscillator or 'single-ended' converter. Properly applied, this very simple device can provide good efficiency (80-90%), and can be used to produce a wide range of output potentials. A characteristic unique to the blocking oscillator converter is its ability to develop very high voltages from a relatively small number of secondary turns.

Before we go any further, let's define the terms 'inverter' and 'converter'. An *inverter* changes a DC input voltage into an alternating potential of suitable amplitude and frequency. A *converter* uses an inverter together with a rectifier/filter system to change the inverter's AC output back into a DC voltage.

Whilst the AC output from an inverter may be used directly (e.g., at 50 or 60Hz), the operating frequency of a DC-DC converter is not important, providing that it runs efficiently and doesn't radiate unwanted acoustic or electromagnetic energy.

Several years ago, my first blocking oscillator converters were designed using empirical methods, because I couldn't find any relevant references. Based on the results of many experiments, I gradually developed the following circuit theory. This, in turn, enabled the design procedure to become more refined and the performance of new designs to be made more predictable. The end result was a system for designing blocking oscillator converters quickly (there is only ONE formula involved) and which uses only a handful of readily available components. Although the concepts of this system are unusual, it should suit those designers who need to change one DC voltage to another with a minimum of fuss.

At first glance, the blocking oscillator power inverter (see Fig.1) appears to have a lot in common with a self-excited push-pull inverter. Both types use a transformer and have a primary winding or windings which are switched across the supply rails, under the influence of positive feedback. There are, however, wide fundamental differences in the way they operate. In order to be able to effectively use the blocking oscillator inverter, it is necessary to understand exactly how it works. It will then be your hard-working and obedient servant.

Basic circuit theory

The 'blocking oscillator' was first configured using vacuum tubes, and the technique was widely used for synchronised oscillators, frequency dividers and similar devices. The circuit arrangements varied considerably, but were characterized by a brief, strong flow of plate current, followed by a period of non-conduction as the grid was 'blocked' – hence the name.

The truth is that these circuits have very little in common with transistor power blocking inverters. In valve circuits, the operating frequency was determined principally by an R-C network, and the transformer was strictly a tightly coupled feedback device. But in the circuit of Fig.1, the non-conducting period is determined by the manner in which the stored magnetic flux is removed from the transformer core. During this time, the transistor is held in a non-conducting or 'blocked' state, so the description 'blocking oscillator' still applies.

Experience has shown that the primary circuit configuration shown in Fig.1 is, apart from being the simplest possible arrangement, the most satisfactory for use in a wide range of applications. It operates as follows:

The collector current of transistor Q flows through the primary of transformer TR, and forward operating bias is supplied through resistor R, via the feedback winding. Capacitor C ensures

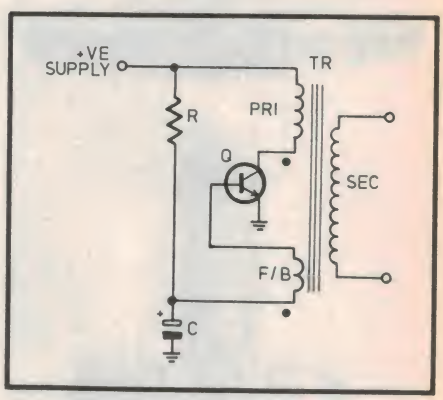


Fig.1: The basic circuit of a blocking oscillator inverter.

that the bias end of the feedback winding is bypassed at the operating frequency of the inverter. The circuit is caused to oscillate by applying a signal to the base from the feedback winding. The windings are connected so that the signal *voltages* at the collector and the base are 180° out of phase. Since a voltage phase inversion occurs within transistor Q, the overall feedback is positive.

When power is first applied to the circuit, the collector current in Q moves toward saturation due to the forward bias supplied through R. Once this movement is under way, the presence of positive feedback causes the transistor Q to be driven rapidly into saturation.

After a period of time (determined principally by the DC input voltage, the low frequency response of the transformer and the level of power loading), the slowing rate of change of core flux (picked up by the feedback winding and fed to the base) is sufficient to cause a small drop in collector current. The positive feedback present then ensures a rapid transition to the cut-off, or 'blocked' state. At this point, the magnetic flux stored in the core of TR begins to collapse.

When the voltage induced into the feedback winding by the collapsing field can no longer oppose the forward bias supplied through R, the positive feedback present forces a rapid return to the saturated state. This cycle of oscillation will then be repeated indefinitely whilst power is applied.

Another way of viewing the transistor blocking oscillator's operation is to see it as an overdriven sine wave oscillator. During the first half-cycle of operation the waveform generated is rectangular rather than sinusoidal, due to the large amount of positive feedback. Because the oscillator transistor Q can only operate uni-directionally, the core is left with a high flux level which must somehow be dissipated before the transistor can switch on again.

It can be seen that one complete cycle of oscillation is made up of an *active* state (flux build-up) and a *passive* state (flux removal). This contrasts with a push-pull inverter, where the flux is actively forced to change direction every half-cycle.

Operating frequency

The mechanism which determines the operating frequency of a power blocking oscillator is very complex, as it is influenced in some way by every circuit parameter. Those which have a major effect are the construction of the transformer, the type of secondary loading, the secondary DC load current and the DC input voltage. In practice, it is not uncommon for the frequency to vary over a range of 5:1 or greater as the input voltage and output load current is varied.

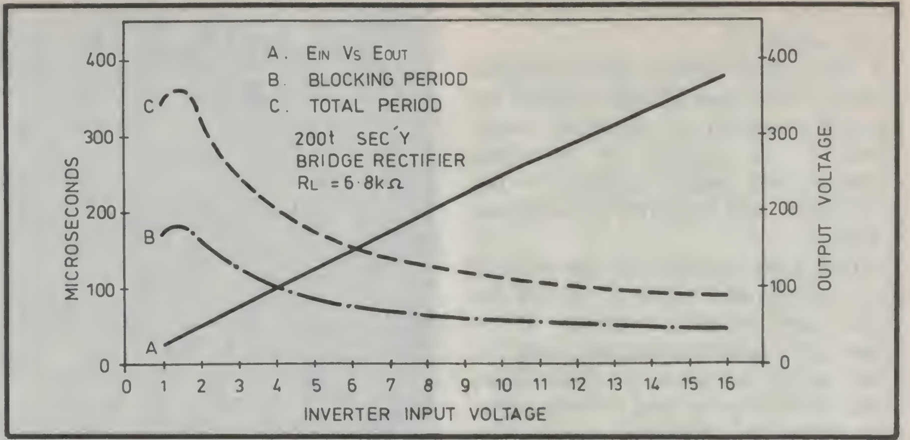


Fig.2: Voltage and frequency characteristics of a blocking oscillator converter with bridge rectifier and fixed 6.8k load connected to the secondary.

The total period of oscillation is the sum of the saturation period and the blocking period. For a given secondary inductance, the mechanism which determines the length of the blocking period may be explained by using Lenz's Law.

During the blocking period, the collapsing flux will induce a voltage in the secondary winding. If the secondary is heavily loaded, this induced voltage will give rise to a correspondingly heavy secondary current. From this current will arise a flux, the polarity of which is such as to oppose the fall in core flux. The blocking period (the time taken until core flux turnover initiates a new saturation period) will therefore be relatively long. As the secondary load is decreased, the opposing secondary flux will weaken. The fall in core flux will now occur sooner, leading to a shorter blocking period. When the blocking cycle runs out of energy a new saturation period will be initiated, during which time the energy extracted (plus losses) will be replaced.

For a fixed DC voltage input, loading during the saturation period and heavy loading during the blocking period will both cause the operating frequency to decrease. When loading occurs during both periods, these effects are cumulative. When a capacitor-input bridge rectifier is used with significant output loading, both periods are of equal length. Fig.2 shows the relationships between supply voltage, output voltage, blocking period and total period for a converter where the secondary winding feeds a constant load resistance via a capacitor-input bridge rectifier circuit.

It is a characteristic of the basic inverter circuit to be described in this series that for any given output loading the lowest frequency of operation will occur with a DC input voltage of about 1.5V. As can be seen from Fig.2, the operating frequency will increase when the input voltage is swung above and below this value.

Loading considerations

By now, we have seen that the action of the blocking inverter is very much different from that of the push-pull inverter. As a result of this, there are several constraints and cautions associated with the methods we use to draw power from the secondary winding(s).

It is useful to think of the action of power blocking oscillators as being comprised of two components: the *power* (or saturation) stroke, and the *induction* (or blocking) stroke. During the power stroke, the potentials generated from secondary windings follow conventional relationships. On the induction stroke, the voltages generated are a function of the initial core flux, the number of secondary turns and any resistive loading present.

It is possible to load both the power and induction strokes together in such a manner that the inverter behaves (in most respects) like a conventional push-pull type. This is the most straightforward mode of operation, and will generally be the first choice for designers.

Because of the fundamental differences between the power and induction strokes, the blocking oscillator is much more sensitive to secondary loading than a push-pull inverter. The characteristics of the three main rectifier configurations are summarised below, and will be discussed in more detail in the second of these articles:

(1) The *capacitor-input bridge rectifier* is the most useful configuration, as it assures good waveform symmetry and

predictable performance at all power levels (see Fig.2).

(2) The *voltage doubler* allows a higher voltage output than a bridge rectifier for the same number of secondary turns. However, its control of waveform symmetry and output regulation is not as effective, and therefore its usefulness is limited.

(3) *Half wave* rectification can be used to selectively load either or both of the power and induction strokes. If by means of a half-wave rectifier only the power stroke is loaded, the diode(s) become reverse biased and disconnect the load during the induction stroke. With an open circuit secondary, there is then no current available to produce a field in opposition to the fall of core flux during the blocking period (Lenz's Law).

Under these conditions the voltage generated can be extremely high, leading to the possible destruction of the transformer's secondary winding, the rectifier diode(s) or the oscillator transistor.

Properly controlled, this characteristic can be put to use for generating very high voltages from a secondary winding of relatively few turns.

DC output voltage

Factors determining the rectified output voltage from a power blocking oscillator converter are as follows:

(a) For *power stroke* loading only,
  (i) N_s/N_p turns ratio
  (ii) DC input voltage to inverter
  (iii) Resistive loading on secondary (normal regulation effect only)
  (iv) Oscillator forward bias (up to a certain optimum value)

(b) For *induction stroke* loading only,
  (i) N_s/N_p turns ratio
  (ii) DC input voltage to inverter
  (iii) Resistive loading on secondary ('constant-power' characteristic) – see next section
  (iv) Oscillator forward bias (up to a certain optimum value)

Whilst control of the output voltage by means of forward bias can be useful, I have found that once an optimum value of forward bias resistor has been determined, this value will be maintained for a wide range of inverter input voltages (i.e.,less than 1V to over 20V). With this input voltage flexibility, control of the output voltage by means of a feedback regulator can be implemented very effectively (see next section).

Regulation performance

A fundamental difference between the blocking oscillator inverter and the push-pull inverter is that the blocking oscillator's primary circuit draws power only during every alternate half-cycle of operation. Due to rectification and filtering the secondary DC power drain is constant, so power for the load during the induction stroke is supplied from the magnetic flux stored in the transformer. The manner in which this stored energy is transferred to the load will largely determine the inverter's regulation characteristics.

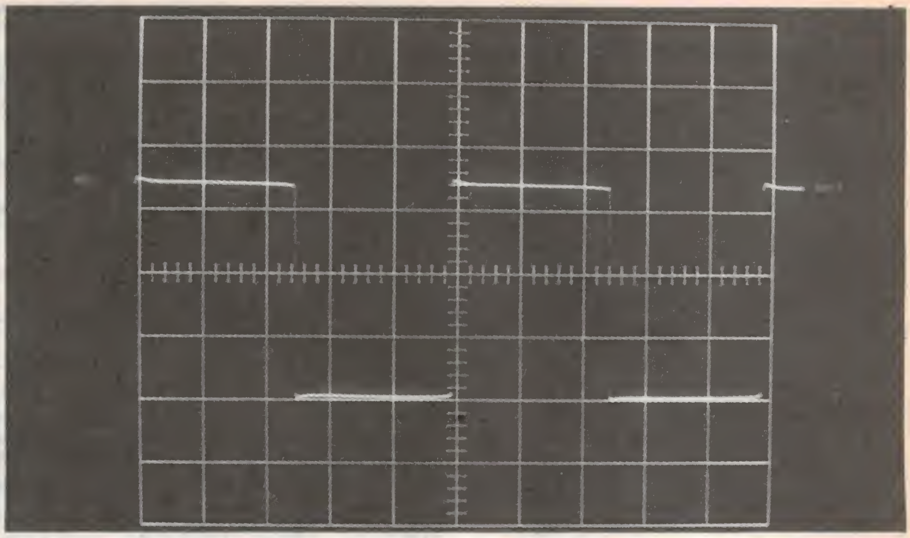


Fig.3: Typical secondary voltage waveform of a blocking oscillator when loaded with a bridge rectifier.

When the secondary is supplying power during the induction stroke, the primary circuit is switched off. So if the secondary loading is increased, it cannot call upon the primary circuit for this extra power requirement. Since the energy developed from a fixed amount of collapsing flux is constant, the inverter behaves as a *constant energy* device during the induction stroke.

According to Lenz's Law, increased secondary loading will slow the rate of change of core flux (see earlier). This will result in less voltage being induced into the secondary winding (Neumann's Rule). Therefore, when the induction stroke is loaded the output voltage will decrease in proportion to the loading. At the same time the pulse width will increase (see section 3), so the total output power will remain constant.

The regulation characteristicis therefore inherently poor during the induction stroke, and if a constant voltage output with varying load resistance is required *when using this mode only*, some form of voltage regulation must be provided.

When the secondary is loaded by means of a capacitor-input bridge rectifier, both the power and induction strokes are used and the over all regulation characteristic improves greatly. Because the bridge rectifier forces the power and induction strokes to share the same filter capacitor, the voltage and power in each stroke is equalised and the voltage waveform becomes symmetrical (see Fig.3). This secondary con -figuration produces the best regulation figure, which is generally less than 20% for a change in load current from 15% to 100%.

If it is required to enhance the converter's natural regulation characteristics, external voltage regulation systems may be introduced. The simplest (but least efficient) of these is the shunt current regulator – e.g., a zener diode.

A more efficient technique is to employ a feed back voltage regulator, which works by operating the inverter from a variable DC voltage source, the value of which is determined by comparing a divided fraction of the secondary output voltage with a fixed reference potential. Examples of this technique will be found in the third of these articles.

If a feedback regulator of this type is used in conjunction with *induction stroke loading only*, it is important to note that when the load current is increased the output voltage will tend to fall because of the 'constant power' characteristic. As soon as this downward trend is sensed, the regulator feeds more voltage to the input of the inverter so that a constant output potential is maintained. The input current therefore increases due to the increasing input voltage, and *not directly* as a result of the increase in secondary current.

In Part 2 of this series, we will make use of the above circuit theory to establish a simplified design procedure. We will also look at the various methods available to draw power from the secondary circuit.

Solid State Update

KEEPING YOU INFORMED ON THE LATEST DEVELOPMENTS IN SEMICONDUCTOR TECHNOLOGY

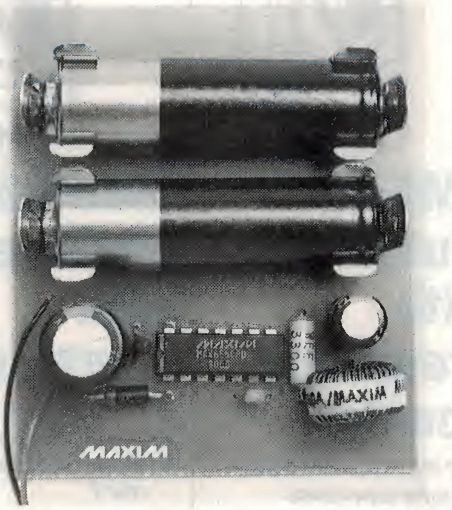
Low resistance power MOSFETs

Siliconix has released two power MOSFETs that are specified with a maximum on-resistance of just 14 milliohms.

The 60V/60A SMP60N06-14 has the lowest on-resistance available in a TO-220, and the 60V/70A SMW70N06-14 in a TO-247 package has the lowest on-resistance in that package.

Both these new parts are suited for modern automotive applications where cool operation and small size are vital. The parts can replace two devices in situations where designers have been paralleling MOSFETs to reduce on-resistance, or they can be used to reduce the size of heatsinks. In either case, the size of the end product is smaller. The low on-resistance also means that the devices are able to handle higher curents in practical situations.

For more information, circle 275 on the reader services coupon, or contact IRH Components, 32 Parramatta Road, Lidcombe 2141; phone (02) 748 4066.



3V/5V converter evaluation kit

Veltek's new MAX655 evaluation kit demonstrates the performance of the MAX655 +3V to +5V DC-DC converter in a standard application circuit, saving time and money by simplifying prototyping at an economical price (30.00 per kit). The kit contains a printed circuit board with low-noise layout, a MAX655, and all passive components needed for a +5V, 300mW power supply powered from two AA batteries.

The MAX655 is one of a series of DC-DC converter ICs that operate from low input voltages, such as those supplied by single or dual-cell batteries. Unlike previous circuits, Maxim's designs minimise the losses caused by MOSFET on-resistance (or bipolar-transistor base currents) used as switch elements. Maxim's circuits internally generate a +5V supply to overdrive MOSFET switches, thus reducing their on-resistance and losses down to -1V voltage levels.

The MAX655 family also features a low battery indicator and can run in standby mode to prolong battery life. A power ready output controls external circuitry when standby mode is used.

For more information, circle 276 on the reader services coupon, or contact Veltex, 22 Harker Street, Burwood 3125; phone (03) 808 7511.

1Mb SCRAMs have 15ns access time

EDI has introduced five new megabit density static RAMs aimed at the high performance commercial market.

The EDI design team has updated the peripheral circuitry of a standard megabit design to boost access time to 15ns, reduce noise, and to produce five products through bond-out options.

The complete line consists of three organisations: 128K x 8, 256K x 4 and 1M x 1. In addition, the 128K x 8 is available with single or dual chip enables, and the 256K x 4 with either common or separate input/output lines.

The 256K x 4 devices are designated as EDI84256CSA for the common I/O version and EDI84258CSA for the separate I/O product. Both are available in speeds of 15, 20, 25 and 35ns and in both 400mil-wide DIP and SOJ package styles. Pin count is 28 and 32 pins, respectively.

The 1M x 1, EDI811024-CSA, also boasting access times of 15 through 35ns, is available in 28-pin DIP and SOJ.

The EDI88130CSA 128K x 8 device is available in 32-pin DIP, SOJ and ZIP package styles. The single chip-enable version is designated as EDI88128CS. Its speed range is 20 to 35ns.

A configurable logic feature allows the manufacturer to select any one of the five organisations at assembly, rather than through a mask option. Both the manufacturer and the customer benefit from this approach.

Full device characterisation data applies to the full family of devices; only partial additional resting is required for each organisation.

For more information, circle 272 on the reader service coupon or contact K.C Electronics, 3/1-7 Balaka Place, Bundoora 3083; phone (03) 467 4666.

Variable gain amplifier

Hewlett Packard has released the HPVA-0180, a silicon monolithic variable gain amplifier in a plastic surface mount SO-8 package.

It is designed for wide or narrow bandwidth applications from DC to 2.5GHz. The amplifier provides 20dB gain (26dB in differential operation) with 20dB gain control over its entire DC to 2.5GHz bandwidth. It dissipates only 250mW from a single 6V power supply. The device may be operated in any combination of single-ended or differential input/output configurations.

The internal signal path of the amplifier is fully differential to achieve the highest possible immunity against transition noise. The HPVA-0180 also features a band-gap voltage reference to stabilise the bias against temperature variations, and a gain control lineariser for linear gain change with gain control voltage variation.

For more information, circle 274 on the reader services coupon or contact VSI Electronics, 16 Dickson Avenue, Artarmon 2064; phone (02) 439 4655.

Solid state relays

Australian based and owned company Fastron Australia has introduced a range of solid state relays and assemblies engineered for reliable performance.

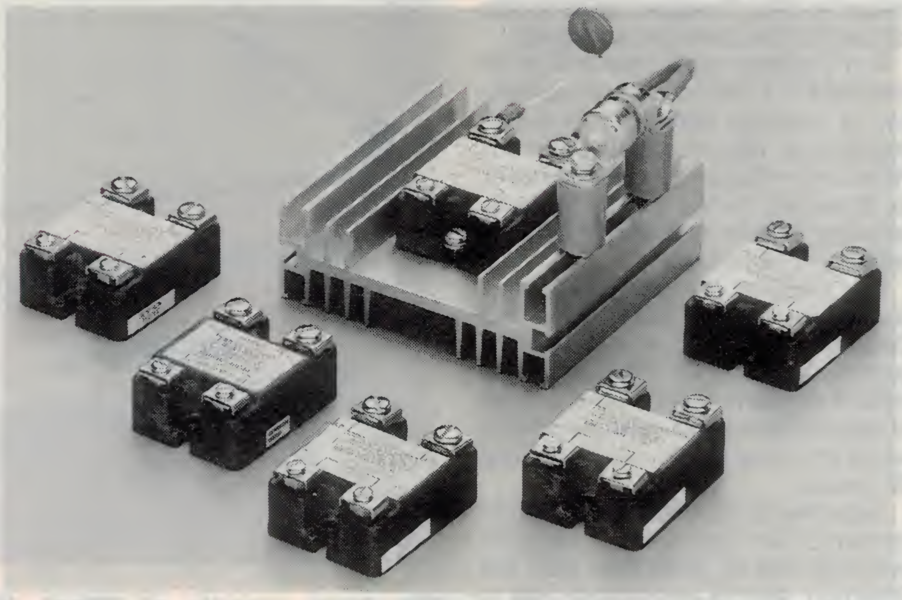
The relays are based on a dual back-to-back SCR design (not triacs), which have a service life far superior to mechanical contactors. Current ratings available are 25, 40, 55, 75 and 90 amps, with either AC or DC control inputs, as well as zero cross or random switching.

Each unit comprises a patented fused copper lead frame with a ceramic baseplate, giving improved thermal and power cycling performance. The units can be switched more rapidly than electromechanical devices, ensuring precise control.

Complete assemblies, comprising heatsink, semiconductor protection fushing, varistor protection against transient voltage spikes, cooling fan (on units about 75A), solid state relay and mounting hardware are available ex stock.

Fastron can also supply custom-built relay assemblies for special applications.

For more information, circle 271 on the reader services coupon, or contact Fastron Australia, PO Box 1212, Dandenong 3175; phone (03) 794 5566.

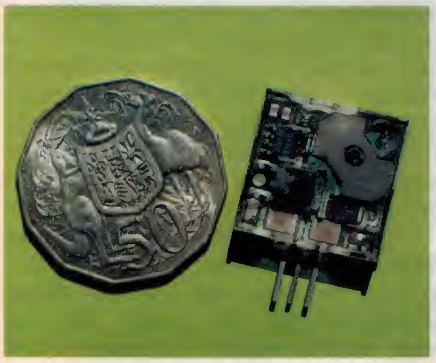


High efficiency switching regulators

An efficiency better than 85% — without a heatsink — is the main advantage in a line of Integrated Switching Regulators (ISRs) available from Alpha Kilo. The Trendsetter 78SR C series of three terminal ISR's from Power Trends is a range of 1MHz, three terminal devices offering high power densities.

The 78/79 series ISRs have a maximum output current of 1.5A and a laser trimmed output voltage. They offer extremely high efficiency (>85%) and state-of-the-art power density (40 to 200W/cu in).

Not only do the converters run without a heatsink, but they also need no external components. An inductor is included within the package. Short circuit and over-temperature protection are also provided. The converter represents a cross between conventional constant frequency, voltage mode and constant frequency current mode design. In addition to the built-in inductor, the package also contains capacitors and EMI filters.



These devices are claimed to be ideal for distributed power supply applications. Because of their extremely low heat dissipation, MTBF is specified in excess of one million hours.

For more information circle 280 on the reader services coupon, or contact Alpha Kilo Services, PO Box 180, Lane Cove 2066; phone (02) 428 3122.

Micropower CMOS comparators

A new family of micropower CMOS comparators from SGS-Thomson Microelectronics is designed to replace traditional bipolar parts such as the LM393 and LM339, offering similar response times with greatly reduced power consumption.

The TS3702 and TS393 dual comparators, and the TS3704 and TS339 quad comparators have typical supply currents of only 10uA/comparator, compared to 200uA/comparator for the bipolar parts.

The TS393 and TS339 have open drain outputs; the TS3702 and TS3704 have push-pull CMOS outputs, eliminating the need for external pull-up resistors. These devices all offer an extremely low input bias current of typically 1pA, compared to around 25nA for the LM393.

The 4um dual layer polysilicon gate process gives excellent linear performance, while the use of only four critical alignments ensure competitive manufacturing costs. The devices operate over a wide supply voltage range of 3-18V and provide ESD protection to more than 2kV for all pins.

For more information, circle 278 on the reader service coupon, or contact Promark Electronics, PO Box 381, Crows Nest 2065; phone (02) 906 1300.

Silicon Valley NEWSLETTER

US nearly had Gulf chip crisis

The US and its allied forces in the Gulf War narrowly escaped a crisis in the supply of weapon systems, because Japanese component manufacturers refused to obey Pentagon orders to ship critical ICs that power those weapons.

In a stunning report scheduled to be published in a California-based newsletter, an unnamed high level Bush Administration official explains how the White House had to pull out nearly all of its diplomatic strings to get the parts, including high level talks at the Japanese embassy in Washington.

The situation has sent shockwaves through the military establishment and Congress, and may serve as the ignition point for an all-out US effort to develop reliable domestic sources for a number of semiconductor and other products in which the Japanese are now controlling the market.

According to the White House official quoted in the May issue of the *SAM* newsletter out of Santa Rosa near San Francisco, the US government 'had to jump through hoops' to secure critical supplies of Japanese high-tech components used in weapons deployed in Operation Desert Storm. The report states that the Pentagon's Japanese chip vendors, whose names have not been disclosed, said they could not shelve or delay contract deliveries of similar parts to their commercial customers in the VCR, automobile and other markets in order to meet the sudden need of US forces in the Gulf.

Experts on Japan believe the Japanese companies were probably afraid of the political backlash they might face if they were seen in the public eye as favouring the military over commercial customers. Since the first reports of the *SAM* story, a number of government officials have confirmed to US news organisations that they were aware of the problems with Japanese component suppliers during Desert Storm.

"I understand that our government had to go hat in hand to the Japanese embassy in order to get certain things supplied," said Richard Van Alta, director for technology policy at the Institute of Defense Analysis, a Washington based military think-tank.

Industry and political analysts said the incident may radically alter the hands-off attitude of the Bush Administration towards the high-tech industry's struggle to keep up with Japanese and other foreign competition.

The latest example of Silicon Valley creativity: Nature's Cradle, a microprocessor controlled bassinet that reduces the shock a baby feels after leaving it's mothers womb. Made by Milpitas firm Infant Advantage, it encloses the baby snugly between bolsters and rocks it gently — with reassuring uterine sounds. Like all new technology, it isn't exactly cheap, though. The domestic model costs US$1295, while the hospital version is around $4000.

Cheaper chip for 'caller ID' phones

A new chip from Sierra Semiconductor in San Jose is expected to vastly speed up the development of a new generation of smart telephones and answering machines that, among other things, will identify the telephone number of any caller.

Although so-called 'caller ID' phones and services have become available in selected areas in the United States, the high cost of the service and the phones, which come with a display, has kept sales down. But Sierra said its new $2 Caller-ID chip will enable telephone manufacturers to build caller ID phones and add-on boxes that will sell for as little as $50. The company has already initiated contract talks with 10 manufacturers, and the first Sierra-based Caller ID phones could emerge in stores within a year, according to company vice president Don MacLennan.

Analysts agreed the new chip could mean a major boost for Sierra, a privately held company with sales of about US$60 million. The market may be huge, with as many as 10 million units

sold per year after the phones become widely available. Besides telephones, the Caller ID feature can also be easily built into answering machines with the Sierra chip.

Although Caller ID has met with widespread public approval, some privacy advocates have argued that the feature constitutes a violation of the caller's privacy as the person he or she is calling would instantly know what number the call originated from. In some cases, this may cause problems, for example, for a battered wife hiding from her husband.

But even the privacy advocates concede there is little they can do to stop a product which appears to have such a broad market appeal, particularly with millions of individuals and businesses who regularly receive harassing phone calls.

Memory cube could hold one trillion bits

Imagine the equivalent of 200,000 100-page novels, stored in a plastic-like cube the size of a sugar cube. That may not be a fantasy for long. Researchers at the University of California at Irvine (south of Los Angeles) announced they have developed a prototype of the optical memory cube.

The first version of the cube, developed with financial support from the Pentagon's advanced research DARPA group, is capable of storing only 1000 bits of data. A fully developed cube, however, could store as much as one trillion bits. That would be the same amount as can be stored on 3000 average PC hard disk drives.

The prototype of the memory cube was made of a polymer plastic material. A second material that chemically reacts to laser light is uniformly dispersed throughout the cube.

Storing bits of data inside the cube is accomplished when the laser beam is split into two beams, which enter the cube from different directions. At the point where the two beams intersect, their light energy is absorbed — changing the reactive material at that point from clear to blue. Blue or clear spots at each location in the cube are thus used to signify a stored '1' or '0'. Retrieving the data from the cube is accomplished by hitting the cube with a second laser beam, which causes the blue spots to emit a red light. This is subsequently 'read' by a sensitive detector. Whereas the presence of a red light signifies a stored '1', the absence equates to a '0'.

The cubes themselves are relatively simple to build and use very little power. But there are several major technical obstacles to overcome before the cubes become a marketplace reality. Most notably, methods have to be developed to speed up the process of writing and reading data into and out of the cube. Also precautions must be developed to prevent data from being erased at room temperature, as is the case with the prototype cube.

A second major advantage of the cube, besides storage capacity, is that it is a non-volatile form of memory, retaining data while the power is turned off. That would enable the cubes to compete with EEPROM and Flash EPROM memory chip cards, as well as optical and magnetic data storage cards and disks.

Mitsubishi to second source IBM mainframes

Japanese mainframe customers, looking to buy an original IBM mainframe, now can choose from two vendors. For the first time in its history, the Armonk computer giant is allowing another company to resell some of its mainframe computers under their own brandname.

In IBM's latest effort to broaden its business in Japan, the company announced the signing of a reseller agreement with Mitsubishi Electric. Under the terms of the agreement, the Japanese company will resell 9121 mainframe systems, machines that operate on the low-end of IBM's 390 series mainframe scale. Mitsubishi will sell the systems under its brandname. Mitsubishi officials said they expect to sell some 900 of the machines, which vary in price from US$1-5 million, during the next three years.

Just a few months ago, IBM has allowed more than a dozen of Japan's largest electronics companies to produce PS/2 clone systems.

Japan agrees to 20% US chip market share

Japan reportedly has agreed to US demands that its semiconductor industry be entitled to at least a 20% share of the vast Japanese semiconductor market.

After four days of negotiations between US and Japanese trade officials, the two parties overcame a major obstacle to reaching a new agreement to replace the 1986 Chip Trade Agreement, which was due to expire at the end of July. Apparently, the Japanese have dropped their opposition to US demands that a new deal includes a reference calling for Japan to help US chip makers achieve a 20% share of their domestic market. Earlier both government and industry representatives had vowed never to negotiate a new deal based on a specific marketshare target.

But US Trade Representative Carla Hills, under increasing pressure from the US Congress and chip industry, has apparently persuaded the Japanese to change their mind. Possibly, the Japanese have demanded that in return for their concession, the US removes the punitive tariffs it imposed in the late 1980's on a variety of Japanese electronics goods, in retaliation for Japan's failure to live up to the terms of the chip trade agreement.

Industry officials in the US reacted cautiously to the news that the Japanese had agreed to the 20% share. They pointed out that unless the 20% figure is put in the agreement as a fixed target rather than just a goal, the new agreement may lead to even more disappointment and frustration.

IBM says it too has memory cube

Only days after UC Irvine researchers disclosed the development of an experimental three dimensional memory cube, IBM researchers at the company's San Jose Almaden Research Laboratory said they have developed a similar memory device.

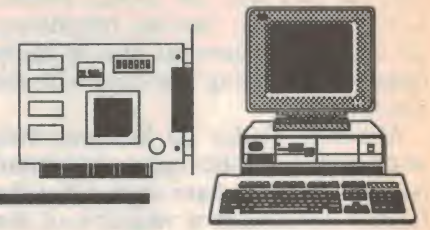
IBM's memory cubes are made of a newly invented polymer made of epoxy and an organic material used in most of today's copiers. According to IBM, a cube the size of a pinhead could store as much as 1.1 gigabytes of memory. The sugar-cube-size memory cube developed at Irvine is said to have a potential storage capacity of one trillion bits.

IBM said that unlike the material used by the UC Irvine researchers, which requires extremely low temperatures to operate, the IBM polymer operates at room temperature. Also writing and reading the data, which is done with split laser beams, would be simpler. IBM's data cubes are also erasable.

Potentially even more important according to IBM, is that its polymer has many other commercial and military applications beyond data storage. The polymer could be used in cameras to create instant holograms. It could produce eye goggles that would protect soldiers and workers against being blinded by laser light.

"It is potentially a whole new material class we are talking about. It has many more applications than data storage," said IBM researcher W.E. Moerner. ■

Computer News and New Products



Data acquisition and analysis

RC Electronics' data acquisition and analysis system integrates high speed software code with a powerful acquisition array processor, designed to run on an ordinary PC. This achieves the high performance specifications and ease-of-use found in dedicated instruments.

The hardware consists of an IS-16 data acquisition plug-in board with 64K memory. It has 12-bit resolution, up to 16 channel input, and a wide sampling rate varying from a maximum of 1MHz (1us per sample) for waveform digitisation to 0.03Hz (30s) for data logging.

Unlike other A/D boards, the IS-16 operates independently of the PC. Direct access to the onboard memory eliminates the need for data transfer between the A/D and computer memories. And the double buffered memory configuration allows computer access to one bank while the other acquires new data.

The Enhanced Graphics Acquisition and Analysis system (EGAA) is the software. An instrument-like graphics display allows the manipulation of all acquisition and analysis parameters within individual operations.

They are all controlled by the PC keyboard by menu driven software, instead of by adjusting different knobs and dials on the instrument rack. Raw or processed data can be automatically saved to the computer's hard disk at predefined intervals.

Some of the features of EGAA are the emulation of a monitoring scope for lab setup and calibration, and of a digital storage oscilloscope for capturing and measuring transient signals.

The real-time interactive software instantly updates to show the results of online parameter changes, including pretrigger and trigger condition and sampling rates.

For more information, circle 161 on the reader services coupon, or contact Hadland Photonics, PO Box 323, Glen Waverley 3150; phone (03) 560 2366.

Industrial control

The COMH030 and 130 range of cards allows a PC/XT/AT to communicate in RS422/485 format, which provides good noise immunity and fast baud rates per travel distance, at low cost.

The COMH cards are available as single, dual or quad RS422/485 communication cards in XT version using the 3250 UART, and the AT version using the 16450 UART, with extended modes. Thus writing to the communications adaptor is like writing to a standard PC serial port, while providing superior differential transmission.

Each port may be set for half duplex transmission RS485 operation, or full duplex transmission RS422 operation. Base address and interrupt request lines are switch selectable to avoid bus collision.

Although the cards are easily programmed using standard communication protocols, two software packages are available for easier

development. The Communications Utilities software consists of utilities such as device drivers for up to eight serial ports, to initialise and redirect output to ports COM3 to COM8, and baud rate etc.

The Communications Buffer software allows the PC to be used for interrupt-driven communication. Baud rate, parity and start/stop bits are able to be set individually for each port.

Communication overhead is handled in the background enabling you to run other programs.

For more information circle 162 on the reader services coupon, or contact Boston Technology, PO Box 415, Milsons Point 2061; phone (02) 055 4765.

Fast LIM EMS memory card

The Juko EMS Turbo memory board is LIM EMS 3.2 and 4.0 compatible, and is claimed to provide the fastest EMS memory access available, by requiring no wait states during EMS accessing.

It provides from 256KB to 6MB of memory, which may be configured into any desired combination of expanded (EMS) and extended memory.

The board uses 411000/414256 chips, supported by a custom LSI ASIC device to increase access speed and reduce chip count. It is 8/16-bit configurable for PC/XT/AT or 386 systems, and is compatible with both DOS and OS/2.

Software provided with the board allows easy menu-driven installation, and also includes an EMS driver, RAM disk driver and print spooler utility.

For further information circle 163 on the reader service coupon or contact NJS Electronics, Unit 4, 673 Boronia Road, Wantirna 3152; phone (03) 887 0377.

Extended PLC control language

Australian firm Procon Technology will be displaying the new extended version of its programmable logic control language PLCX at the PC91 show being held this month (August 11-14) in Melbourne.

PLCX allows convenient 'relay ladder logic' programming of PLC operation, running on any IBM compatible PC, and will be displayed alongside other locally developed software under the 'Australian Software Publishers Association' banner.

To encourage personal shoppers at the show, Procon will also be offering its PLC Starter Pak at the special introductory price of $399 including tax.

The Starter Pak includes all components necessary to use an IBM-compatible PC as an industrial PLC, including an externally mounted I/O card with eight opto-isolated 12V AC/DC inputs and eight relay isolated outputs; an interface card that plugs into any 'short' 8-bit PC slot; the necessary interconnecting cable; and Version 2.5 of the firm's PLC software.

Further details are available by circling 164 on the readers service coupon, or by contacting Procon Technology at either the PC91 show, or via PO Box 655, Mount Waverley 3149; phone (03) 807 5660.

Electronic phototooling

PCB Resources of Melbourne provides a complete phototooling package which includes Gerber conversions, photoplots, manufacturing sheets and NC drill discs. The phototooling packages can be tailored to suit any particular PCB manufacturer, therefore saving time and cost.

PCB Resources uses state-of-the-art Marconi photoplotters. Its quality control includes design rule checking of such things as pad, via, tracking clearances, inspection of drilling information for minimum anular ring sizes on pads and vias, and consultation of file data conversion.

Any CAD PCB design will eventually need to be transferred to photographic masters, together with all the relevant NC drill disc and routing information.

PCB Resources offers manipulation of Gerber files to overcome CAD package deficiencies, as well as plotting of Autocad files for PCB or silk screen colour separation film masters.

Fore more information, circle 168 on the reader services coupon, or contact PCB Resources, 5/12 Miles Street, Mulgrave 3170; phone (03) 562 1277.

Graphics file converter

PictureEze from Application Techniques is a new graphics file conversion utility which runs in the Windows 3 environment.

PictureEze can read a wide range of bit-image file formats including the popular PXC, TIF and GIF which are commonly used by paint programs,

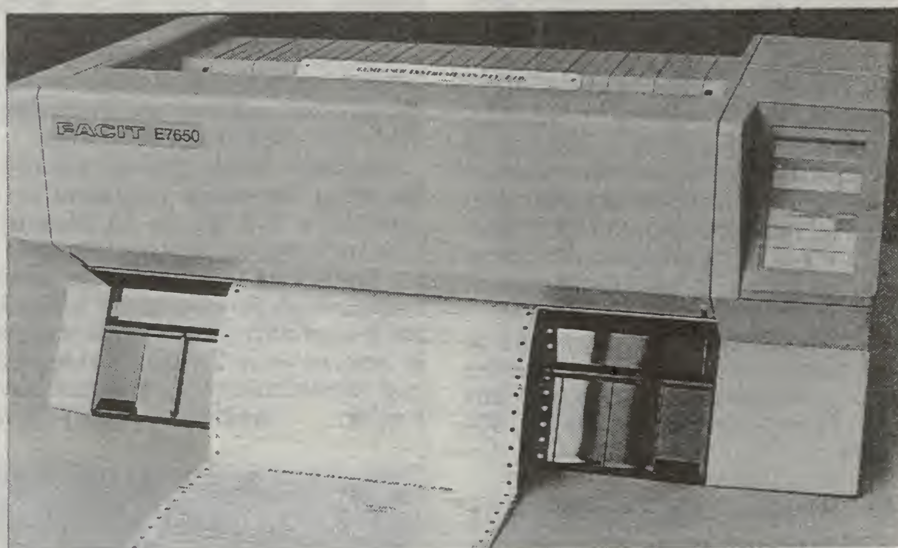
Forms and label printer

Facit has introduced a wide carriage, heavy duty forms and label matrix printer, with exceptional durability, performance, and media handling provisions. The model E7650 incorporates a flat platen and straight through paper path to accommodate the toughest multi-art forms (up to nine part) and adhesive labels, with a demand document fixture to provide zero tear off capabilities.

It is an intelligent printer, which automatically adjusts for form thickness and incorporates a unique FormFinder system that senses top, right and left edges of the form.

With a Quickprint speed of 600cps @ 15cpi, 400cps @ 10cpi, and a high 16" per second paper slew rate, high outputs can be achieved over long periods.

For more information, circle 165 on the reader services coupon or contact Elmeasco Instruments, PO Box 30, Concord 2137; phone (02) 736 2888.



desktop publishing programs and Compuserve respectively. In addition to converting the file format, PictureEze offers the user many options to modify and enhance the image itself.

Modifications include cropping, resizing, reducing the number of colours through dithering, diffusion or colour matching, inverting the colours to produce a negative image, changing the colour content, brightness or contrast, changing the orientation through rotation, mirroring and flipping the image.

The utility can create file formats consistent with the input requirements of most application programs. It can reformat the graphic image into more than 55 distinct file formats. In addition, the user can specify which application the image will be imported into and PictureEze will select the appropriate file format automatically. Recommended retail price is $240.00.

For more information, circle 167 on the reader services coupon, or contact Technical Imports Australia, PO Box 927, Crows Nest 2065; phone (02) 954 0248.

Mathcad 3.0 for Windows

Mathsoft has announced a new version of its Mathcad software package. The new release adds support for Microsoft Windows as well as Electronic Handbooks.

A new feature of Mathcad is the Electronics Handbooks, which service as an online reference library. They contain standard formulas, constants and diagrams, many from the popular CRC reference handbooks. Users have searchable, hypertext access to problem-solving information such as geometrical figures, coordinate transforms and numerous physical constants for use in their Mathcad worksheets. Mathcad 3.0 retails at $650; the Unix version is $750 and the MathStation version for Sun Workstations is $1295. Upgrade to version 3.0 is available for $195.

For more information, circle 166 on the reader services coupon or contact Hearne Marketing Software, 36/458 St Kilda Road, Melbourne 3004; phone (030 866 1766.

Mini terminal

Davidson has announced the first of a new generation of front mount VIP mini-terminals, featuring improved packaging and enhanced software.

This terminal is a complete operator interface module with display, keypad, diecast bezel, and rear cover, operating over a 0 to +70°C temperature range.

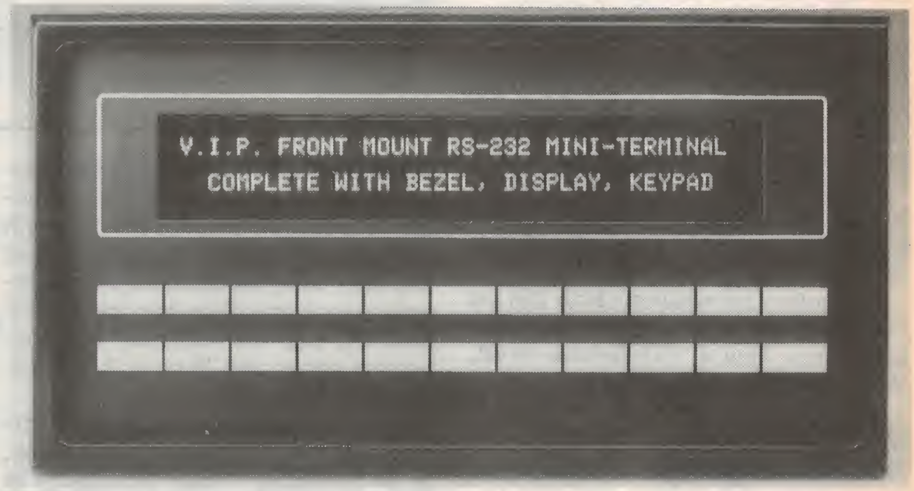
Designated model 3902-03, the new Industrial Electronic Engineers unit combines a two line by 40 character vacuum fluorescent display with a standard two row by 11 column metal dome keypad which provides tactile feedback and featues ESD shielding. The module is designed for applications that require user interaction such as industrial controllers, medical equipment security/safety systems, etc. The display's characters are 0.20" (5.1mm) high and formed by a 5 x 7 dot matrix.

The blue-green characters are suitable for long or short term viewing and are software-dimmable to three levels of brightness. In addition to the standard 90 character US ASCII character set, there are alternate European and scientific characters.

Up to 127 canned display messages can be stored in the unit's EPROM memory, which has been enlarged to approximately 12K bytes. In addition, the contents of string output from each switch to the host system can now be programmed. The switch and display share a common RS232C interface.

Input/output data can be configured as seven or eight bit words with odd, even or no parity, and one or two stop bits; and data can be transmitted at 1200 or 9600 baud. The unit requires only +5.0V DC at 960mA (maximum) at its brightest level.

For more information, circle 169 on the reader services coupon, or contact M.B. and K.J. Davidson, 17 Roberna Street, Moorabbin 3189; phone (03) 555 7277. ■



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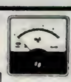
ST160 VU Meter *ST-70W*

Model ST-65



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This is an MS-DOS software and cabling package which enables technicians and engineers to perform serial data comms analysis. It offers sophisticated problem solving facilities at a fraction of the cost of dedicated hardware systems. SerialTest provides a window onto RS232 lines operating either as a passive observer or actively sending data or control signals to simulate either at DTE or DCE device. Triggers can be defined based on error conditions or data to initiate or terminate monitoring sequences.

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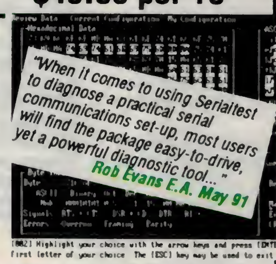

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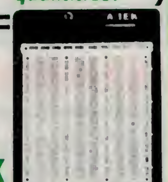

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